

REPORT
ON THE
FORESTS OF CANADA,

IN WHICH IS SHEWN

THE PRESSING NECESSITY WHICH EXISTS FOR THEIR MORE CARE-
FUL PRESERVATION AND EXTENSION BY PLANTING,
AS A SURE AND VALUABLE SOURCE
OF NATIONAL WEALTH.

WITH

AN APPENDIX.

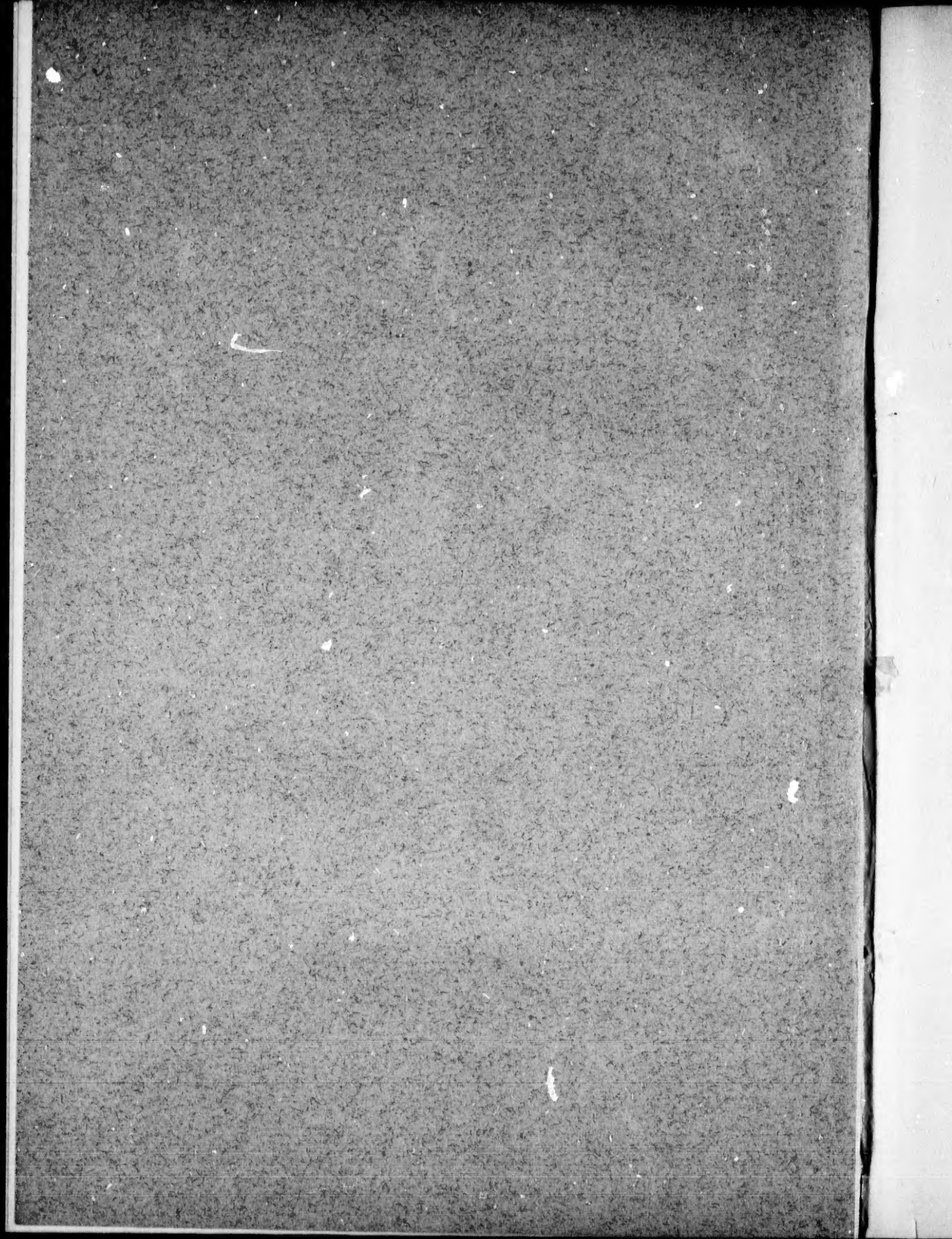
BY

J. H. MORGAN,

FORESTRY COMMISSIONER.



OTTAWA:
PRINTED BY MACLEAN, ROGER & CO., WELLINGTON STREET.
1886.



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GORDON P.O., ~~Essex~~ Co., ONTARIO, 5th March, 1884.

SIR,—In compliance with the communication from your Department, bearing date the 27th February, 1883, instructing me to prepare a preliminary report for the information of His Excellency the Governor General in Council, upon the subject of the protection of the present forests of the Dominion, and also the planting of forest trees upon an extensive scale, I have the honor to submit the accompanying report.

I would observe that this report being, in accordance with your express instructions, of a preliminary character only, I have been obliged to condense it as much as possible, and have thus omitted much interesting and important detailed information, some of it the result of my own personal observation and experience, and much that I had gathered from a careful research among the works of eminent writers on the subject in England, France, and the United States.

As a result of my special inquiry into the matter, I am deeply convinced of the necessity for a more specific and general investigation into the question involved. The increasing and reckless waste of our forests, brought about as much by the destructive carelessness of individuals as by accidental fires, has not received that attention from the Government of the Dominion and the Governments of the several Provinces which the future will show to have been necessary.

The inevitable consequences of further neglect will be, among others, climatic changes, droughts, varied by sudden and disastrous floods, and a great deterioration in the quality of the soil.

I feel it my duty to press these facts upon your attention, and I most respectfully beg to suggest that a joint commission should be appointed by the Governments of the Dominion and the several Provinces to deal with the whole question of the preservation of existing forests, and of the planting of forest trees on an extensive scale, with a view of systematizing some practical measures for the attainment of these most desirable objects.

Appended to the report are copies of the statutes which have been enacted in certain of our Provinces, and also in some of the States of the United States whose condition is similar to our own as regards the need for protection of forests.

Appended, also, will be found condensed accounts of the most disastrous forest fires that devastated our country and the States immediately adjoining us.

I have the honor to be, Sir,

Your most obedient servant,

J. H. MORGAN,

Forestry Commissioner.

Hon. Sir D. L. MACPHERSON, K.C.M.G.,
Minister of the Interior, Ottawa.

PREFACE.

As valuable aids to information while engaged in preparing the following report, I beg gratefully to acknowledge the receipt of books and papers from the Hon. H. G. Joly, Quebec; Mr. Stuart Thayne, Ottawa; the Hon. G. B. Loring, United States Commissioner of Agriculture; Professor Franklin B. Hough, Ph. D., of Lowell, New York; Professor N. H. Egleston, Chief of Forestry Department, Washington; J. L. Budd, Professor of Botany, Iowa University; V. M. Spalding, Professor of Botany, Michigan University; Hon. B. G. Northrop, of Clinton, Con.; Professor Adolphe Lene, Secretary Ohio Forestry Association; F. P. Baker, Forestry Commissioner, Topeka, Kansas; and the Hon. R. W. Furness, Governor of Nebraska.

I also acknowledge indebtedness to the works of Messrs. J. C. Brown, A. Bryant, Humboldt, Hooper, Gray, Loudon, Mehan, Marsh, Michaud, and to the very valuable reports of Dr. Selwyn and Dr. Bell, of the Dominion Geological Survey.

INTRODUCTION.

The following poem appeared some months ago in the *New York Sun*. Its words and its sentiments seem ominously prophetic, and are most appropriate as an introduction to a report on a subject of such importance as the PROTECTION OF OUR FORESTS:—

"A TREELESS COUNTRY.

"I had a dream which was not all a dream."

"A great State was a desert, and the land
Lay bare and lifeless under sun and storm,
Treeless and shelterless. Spring came and went,
And came, but brought no joy; but, in its stead,
The desolation of the ravening floods,
That leaped like wolves or wild cats from the hills,
And spread destruction over fruitful farms,
Devouring, as they went the works of man,
And sweeping seaward Nature's kindly soils,
To choke the water-courses worse than waste.

"The forest trees, that in the olden time—
The people's glory and the poet's pride—
Tempered the air and guarded well the earth,
And, under spreading boughs, for ages kept
Great reservoirs to hold the snow and rain,
From which the moisture thro' the teaming year,
Flowed equably but freely—all were gone.
Their priceless bales exchanged for petty cash,
The cash that melted and had left no sign;
The logger and the lumberman were dead;
The axe had rusted out for lack of use;
But all the endless evil they had done
Was manifested on the desert waste.

"Dead springs no longer sparkled in the sun;
Lost and forgotten brooks no longer laughed;
Deserted mills mourned all their moveless wheels;
The snow no longer covered, as with wool,
Mountain and plain, but buried starving flocks
In Arctic drifts; in rivers and canals
The vessels rotted idly in the mud,
Until the spring flood buried all their bones;
Great cities that had thriven marv'ulously,
Before their source of thrift was swept away,
Faded and perished, as a plant will die
With water banished from its roots and leaves;
And men sat starving in their treeless waste,
Beside their treeless farms and empty marts,
And wondered at the ways of Providence!"

In preparing a preliminary report on the subject of the protection of the forests of the Dominion and the planting of forest trees on an extensive scale, the absence of all data that would aid in forming an estimate of the extent, condition and availability of our forests, leaves all enquiry about the first part of our subject beset with no little difficulty.

The reckless and destructive waste of the great forests of Canada, and of the adjoining States, by fire and by the axe-man, has been for a long time looked upon with much alarm by the more careful and thoughtful of both countries, and has been

a theme of anxious and intelligent discussion with the men who take a deep interest in the future welfare of the country.

The rapidity with which the vast pine and spruce forests of Ontario and Quebec are being exhausted has aroused the fears of the Governments of these Provinces, and it is to be hoped they are now fully awake to the gravity and importance of the situation.

THE ALARM CAUSED BY THE RAPID EXHAUSTION OF PINE AND SPRUCE IN THE UNITED STATES.

The statesmen of the great Republic on our southern border are also giving the subject their careful attention, and commissioners from the United States, and many of the individual States, were sent to Europe to enquire into and report on the protection, conservance, and management of forests in the countries which have the most matured systems.

The danger that is threatened by the destruction of the pine forests is so great that the President of the United States recently, in his Annual Message to Congress, calls attention to the subject; and the Secretary to the Interior, in his Report, thus forcibly calls the attention of the representatives of the people to the same subject:—

"The rapidity with which this country is being stripped of its forests must alarm every thinking man. It has been estimated, by good authority, that if we go on at the present rate, the supply of timber in the United States will, in less than twenty years, fall considerably short of our home necessities.

"It is the highest time that we should turn our earnest attention to this subject, which so seriously concerns our national prosperity."

The Commissioner of Agriculture for the United States, the Hon. Geo. B. Loring, who has more reliable sources of information than many who have spoken and written on this all-important question, says, in his address to the American Forestry Congress, held at St. Paul, Minnesota, in August last:—

"The condition of the pine timber supply is interesting. The destruction of this tree by fire and by the axe of the lumberman is very great. Together with the spruce, it is being rapidly consumed, and I think that the following figures will show what the supply to be obtained hereafter will be, by allowing the exhausted region to recuperate while the comparatively uncut sections are resorted to for filling up the demands of the markets. Investigations recently made show that the supply of pine in Vermont and New Hampshire is exhausted, and that the spruce timber, at the rate the cutting is now going on, will last, in the former State, but 4 years, and in the latter 7; in the State of Maine, pine will last 4 years and spruce 15; in South Carolina, the pine forests will last 50 years, at the present rate of cutting; in California, 150 years; in Georgia, 80 years; in Louisiana, 100 years; in North Carolina, 50 years; in Mississippi, 150 years; in Alabama, 90 years; in Florida, 30 years; in Texas, 250 years; in Wisconsin, 20 years; in Minnesota, 10 years; in Michigan, 10 years; and in Arkansas, 50 years. That the exhausted forests in this list of States can be restored in time there is no doubt, and every means of cultivation and protection should be applied by the people and by the Government, both State and Federal, each in accordance with its own jurisdiction."

The words emphasized in the above quotation from Commissioner Loring are of deep import, and deserve, in as far as they are applicable, our earnest attention.

It must be remembered that Mr. Loring, in his very valuable estimate of the timber supply of the States named, has made no allowance for destruction of forests by fire; nor has he made any reference to the fact that the lumber business in the Southern States, where the largest forests now are, has recently taken an impetus that will add largely to the denudation of the land and reduction of the supply. Some of our Canadian lumbermen have recently invested largely in the timber lands of Arkansas and Louisiana, and are now actively engaged in making, cutting and rafting the timber. As soon as the railroads penetrate these large and hitherto untouched forests, the work of destruction, similar to that which exhausted the supply in the older States, unless checked by wise legislation, will very soon give cause for alarm in those parts.

Railroads are everywhere penetrating the timber regions of the country, many of them being built expressly to get out timber which could not be marketed otherwise. It is but a comparatively short time since this feature in lumbering was introduced, and its direct effect is to hasten the destruction that was already going on too fast. The result of this will be to keep up the supply at the mills as long as there are forests from whence that supply can be obtained.

But while they are doing this, they will be every day hastening the ruin which must inevitably follow—the vast and rapidly increasing destruction that must of necessity ensue, unless prompt and adequate measures are taken to meet future wants, by judicious and extensive planting, and by effectual measures for protecting and economizing our remaining supply.

A strong effort is now being made by the people of the western States to have the import duties taken off lumber. Should this be done, the rapid increase in the demand would cause such an exhaustion in our supplies that the result is fearful to contemplate.

We, in Canada, have had only a foretaste of danger, while our cousins in the United States have suffered severely, and the floods of this year have caused calamities that brought mourning and poverty into many a home. The possible evil results of stripping the hills and the mountains of their leafy covering is shown in the floods that desolated the Ohio valley last spring, causing such terrible destruction of life and property. This is forcibly shown in the Cincinnati *Commercial Gazette*:

"In 1881 we had the lowest water ever known in the Ohio River, and now we have the highest. The reasons are obvious and distinct. Take a mass of hills on the Alleghany and Kanawha Mountains. Let us suppose them clothed with trees from foot to crown, and with underbrush and moss and beds of half-decayed leaves, resting upon the soil that represents the vegetable growth of ages. Each mountain thus covered is an immense sponge. The rain may fall for days, and the greater part of it is absorbed, saturating the soil, the grass, and the leaves, lingering in the bushes and the trees. The half-decayed logs will hold barrels of water, and for weeks after a heavy rain the moisture is trickling away in thousands of flush springs.

"Cut away the trees from these hills; the underbrush perishes, the soil is washed away, and the rocks are exposed. The rain descends the mountains in torrents, to suddenly swell the runs and overflow the rivers.

"Take a thousand hills at the head waters of the Ohio and reduce them to barrenness, and it follows that the river is lower in dry weather and higher in wet weather, and more and more subject to high and low water."

Is it not probable that the causes which led to the disasters in the Ohio are now in action about the head waters of the Ottawa? And may not it be time to inquire whether it is possible to avert the dangers threatened by the overflowing of the Thames, Richelieu and others of our rivers?

PROBABLE DURATION OF CANADA'S SUPPLY.

As to the probable duration of our own timber supply, under the present high pressure of exhaustion, in the absence of official investigation, similar to that which warranted the statement of Commissioner Loring, it would be presumptuous to say. Alarmists place it at a very short period; while many are of the opinion that there is no apparent danger of scarcity of the necessary supply. Mr. Phipps, who has taken much pains in preparing, and has been very cautious in making statements, says that Mr. Little, an authority worthy of respect, and others, put the duration of our supply at our present rate of consumption at ten years. Mr. Phipps says: "We may, I think, consider that the demand is likely to increase, perhaps to double." After quoting some figures from Mr. Little, he again says, after alluding to statistics about Canadian fires: "We may well doubt whether we have five years' supply."

While there is no immediate danger of wood becoming so scarce in the Dominion that we shall have to send abroad for any, yet, at the same rate at which our commerce and our industries are growing, nearly all of the latter requiring large quantities of wood, the building and repairs of railways, of telegraph and telephone posts, all cause such heavy drafts on our supply that we may well be alarmed about

providing for our future wants. These wants are growing as rapidly as the growth of the country; the progress of a country can, to a great extent, be measured by its consumption of wood; and as civilization advances this consumption will increase.

Railroads are great consumers of wood. A new road requires about 2,500 cross ties per mile; and to keep a road in repair 100 ties per mile are required annually. Professor Sargent said, some five years ago, when the United States had 85,000 miles of railroad: "Supposing the life of a sleeper to be seven years, the railroad tracks of the country consume annually 34,000,000 sleepers, or thirty years' growth of 68,000 acres of the best natural wood land. At least 125,000 miles of fencing are required to enclose the railroads of the country, costing not less than \$43,000,000."

We might add statistics, did time and space permit, about telegraph and telephone poles, paper wood pulp, charcoal making, and many other enterprises that require large supplies of wood, and which have to be taken into consideration in our calculations about the future.

FORESTS AN IMMENSE SOURCE OF WEALTH.

In the past our forests have been our greatest source of wealth. Since Confederation alone our exports of lumber amounted to the enormous sum of \$330,520,000, without taking into account what may have been exported in the manufactured state. This is an annual average of \$22,034,663, for fifteen years. During the same period the exports of agricultural products amounted to an annual average of \$17,305,088, and those of another great branch of our industries, our fisheries, amounted to \$5,360,120 annually. During this same period the Provincial Governments collected about eleven millions of dollars in revenue from the product of our forests.

Unfortunately, this rich harvest cannot be reaped much longer, unless prompt measures are taken for the economic use, protection, conservance, and reproduction of our woods. This can only be accomplished by a careful and competent supervision by persons thoroughly qualified, and of reliable integrity, to perform the important duties.

PREVENTIVE ENACTMENTS.

Rigorous laws against trespass, waste, careless or wilful destruction, should be enacted, and vigilantly and fearlessly enforced. With a judicious management, and a proper and economic use, our present forests would last a long time yet, during which the young trees would mature, and thus the danger which seems so imminent would, to a great extent, be provided against.

Nature, through a bountiful Providence, when not obstructed by the hand of man, is ever willing to continue the measure of her benefactions. We have gathered largely of these blessings in the past, and it is now a duty we owe to nature, to ourselves and to posterity, to remedy, as far as possible, the evils which our reckless wastefulness has caused. This, in order to avert calamity, must not be neglected.

THE LOSS SUSTAINED THROUGH NEGLECT.

It is impossible to fully estimate the loss that neglect of our forests in the past has entailed. In fact, the great value and extent of our forest treasure seems to give us neither pleasure nor satisfaction, and it is only when its rapid destruction is becoming apparent that we wake up to what must absolutely be the consequence of our carelessness.

Dr. James Brown, the eminent forester, speaking, some fourteen years ago, about our forests, said:—

"Were those vast forests properly dealt with, they could not fail to be a great source of revenue to the country, and continue to yield annually, for an unlimited time, as much timber as they do now; but, unfortunately, we find indiscriminate felling going on everywhere, and in time this must lead to the exhaustion of the best timber, and render these yet valuable forests comparatively of little consequence."

The past cannot be recalled, but it is not yet too late to arrest the evil. The opinions of men like Dr. Brown are well worth regarding, and we should lose no time before steps are taken that would secure our remaining woods from the consequence of carelessness and waste.

We have seen large money appropriations wisely and liberally devoted to the encouragement of agriculture and the propagation and protection of our fisheries; and it is time that something were done for our forests. Hitherto, they have been looked upon by the Government as a means of revenue, by the lumbermen as a source of wealth, and by the pioneer as a foe, and devoted to destruction.

Our timber interests have been in the past, as they no doubt must be in the future, closely identified with those of the United States. I will adduce some further evidence in support of the estimate of the probable duration of the great lumber-producing States on our border, as the supply in those States will, of course, always exercise a marked influence on our lumber markets.

The Hon. V. M. Spalding, Professor of Botany in the University of Michigan, who has given special attention to the subject, says that, "at the present rate of exhaustion, the supply in Michigan will give out in seven years."

The Hon. Mark Daniel, who is a representative of the State of Minnesota, in a speech full of statistics, made recently by him in Congress, says that, "at the present rate of consumption, seven years will exhaust the supply in Minnesota, Wisconsin, and Michigan." These notes of warning, given to our nearest neighbors, should be taken to heart by us. With these competing markets removed, the price of lumber will be greatly enhanced, and the temptation to further denudation of our remaining forest lands greatly augmented.

CLIMATIC INFLUENCE OF FORESTS.

Great as the loss of our timber supplies would be—much as we might deplore the reduction of revenue to our treasury—inconvenient and expensive as it would be to have to send abroad for our timber for our home wants—there are other and more all-absorbing interests that should impel us to protect and conserve our forests, such as climatic changes consequent thereon, our public health, our agricultural prosperity, our exposure to floods and torrents—in fact, our very existence as a great people.

History gives innumerable instances in ancient, mediæval, and modern times, of the unfortunate results of the wholesale removal of entire forests without any steps being taken for their reproduction. The people knew well enough that they were indispensable to their welfare, from a commercial as well as an æsthetic point of view, but they made no effort to preserve or reproduce them; neither the Greeks nor Romans, notwithstanding their great attainments, seemed to be aware of the final consequences of the destruction that would follow the removal of their noble forests; and the student of history learns with amazement that the rich and glorious groves that once crowned the hills and mountains of these classic lands exist no longer, and that the rugged crags and sterile plains which succeeded are the heritage of wastefulness and improvidence.

In Greece—beautiful Greece—the noble groves that threw shade over the ripping streams exist no longer, neither do the streams which the grateful shade protected. One of the most renowned of the ancient patriarchs, forsaking the noise and turmoil of Athens for the calm and peace that seclusion affords, Basil the Great, writing to his friend Gregory of Nazianzum, from a place in Asia Minor, that is now a desert, said: "I believe that I may at least flatter myself with having found the end of my wanderings. The hope of being united with thee—or I should say my pleasant dreams, for hopes have been justly termed the waking dreams of men—have remained unfulfilled. God has permitted me to find a place such as often fitted before our imaginations; for that which they have shown us from afar is now made manifest to me. A high mountain clothed with thick woods is watered by overflowing streams. At its foot is an extended plain rendered fruitful by the vapors with which it is moistened. The surrounding forests, crowded with trees of various kinds, enclose me as in a strong fortress." Further on he says:—"Shall I describe to you the fructifying vapors that rise from the moist earth, or the cool breeze wafted over

the rippled face of the waters? Shall I speak of the sweet song of the birds, or the rich luxuriance of the flowering plants? What charms me beyond all else is the calm repose of this spot."

It was from this lovely retreat that he described the constantly clear nights, and called the stars, "those everlasting blossoms of heaven."

The forests that sheltered and charmed the great patriarch exist no longer; consequent on their loss are barrenness and desolation; floods to be succeeded by malaria, malaria by droughts, and droughts by famine. All this because the people were reckless in the destruction of their forests, and in ignoring the consequences.

One of the speakers who addressed the recent Forestry Congress at St. Paul said: "The entire coast of the Mediterranean, once the garden of Europe, has been blighted into comparative barrenness by the denudation of its forest lands. The gradual denudation of the once fertile islands of the West Indies, St. Thomas and Santa Cruz, is the result of the primitive forests having been destroyed."

The great discoverer of America, Christopher Columbus, writing from one of these islands, says: "The beauty of the new land surpasses the beauty of the Campagna of Cordova. The trees are bright with an ever verdant foliage, and are always laden with fruit. The plants on the ground are high and flowering. The air is warm as that of April in Castile, and the nightingale sings more melodiously than words can describe."

How sad is the change since the great navigator wrote!

The Hon. G. P. Marsh, United States Minister to Rome, says: "There are parts of Asia Minor, of Northern Africa, of Alpine Europe, and of Greece, where causes set in action by man have brought the face of the earth to a desolation as complete as that of the moon, and yet they are known to have been covered with luxuriant forests, verdant pastures, and fertile meadows, and a dense population once inhabited these now lonely districts. The fairest and fruitfulest provinces of the Roman Empire, formerly endowed with the greatest superiority of soil, climate and position, are completely exhausted of their fertility, or so diminished in their productiveness as, with the exception of a few favored cases that have escaped the general ruin, to be no longer fit for affording sustenance for civilized man. If to this realm of desolation we now add the wasted and lonely soils of Persia and the remoter East, that once fed their millions with milk and honey we shall see that a territory larger than all Europe, the abundance of which, sustained in bygone centuries a population scarce inferior to that of the whole christian world of the present day, has been withdrawn from human use, or, at best, is only inhabited by tribes too few, poor and uncultivated to contribute anything to the general or natural interests of mankind."

Mr. Marsh also alludes to the physical deterioration of many parts of Europe, which, in some localities, has been so rapid that a single generation has witnessed the beginning and the end of the melancholy revolution. He says:—"A desolation like that which has overwhelmed the once beautiful and fertile regions of Europe awaits important parts of the United States, (might not Canada be included?) unless prompt measures are taken to check the action of the destructive cause already in operation."

In Canada we have many bleak and rugged hills that once were covered with valuable and beautiful forests. The early navigators of our rivers and lakes were charmed and surprised at the extent of the luxurious forests that reached without limit far away from the banks and shores. Could the spirits of Cartier and Champlain return from the spirit-land and visit the banks of that most beautiful of rivers, the St. Lawrence, they would be saddened to see that civilization had not guarded from destruction the beautiful groves and woodlands with which the Great Architect had ornamented the land. The luxuriant vines and clustering grapes that festooned and adorned the woods on the beautiful island of Orleans, which lies in sight of the citadel of Quebec, impelled Cartier to baptize it "Isle de Bacchus." Vines and groves have disappeared from islands, capes and shores, and there are neither woods nor forests to check the chilling sweep of the north-east gale, as in its ruthless fierceness it comes up the valley of the great river from its home among the icebergs.

The Hon. H. G. Joly, to whom we owe much for the valuable aid and information which he is always willing to give in the interests of forestry, commenting on our wastefulness, says: "The result stares us reproachfully in the face, especially in the Province of Quebec, the oldest Province of the Dominion. The old settlements are painfully bare of trees; you sometimes go miles without seeing a tree worth looking at, and the passing stranger fancies himself in a country more denuded of trees than the older parts of Europe. There is a large district of good agricultural land south of Montreal, where the scarcity of firewood, which is a matter of life and death in a climate like ours, has compelled many a farmer to sacrifice a fine farm and leave the country. There are many other parts nearly as bad, and, unfortunately, the process of destruction is going on even now in more places than one."

What Mr. Joly says of Quebec is, unfortunately, applicable to all the other Provinces. The scarcity and high price of fuel, the difficulty of obtaining material to replace the worn-out fences, together with short crops, often caused by the want of sufficient tree-shelter in winter and the absence of moisture in the summer, has caused the discouraged farmer to abandon land that he, unwittingly, had impoverished. But, under the light which experience is giving, it is to be hoped that further destruction will be checked, and that many of the old places will be restored to their pristine beauty and verdure.

ENQUIRY AS TO HOW FORESTS ACT AS FERTILIZERS.

It may be proper here to inquire how the removal of the forests, in the countries we have alluded to, could have caused the disasters and desolation which befall them.

These lands, like the western part of this continent, were subject to periodical droughts—had their wet and dry seasons. The forests, with which the hills and mountains were covered, acted as reservoirs to hold, retain, and economize the waters which the rainy season showered upon them. The soil in the forest is loose and spongy. The roots and rootlets are as so many pipes penetrating the earth, leading the water into the deeper soil. The heaps of leaves, the layers of brambles, the beds of moss, all combine to hold and retain the waters, while the shade afforded by the foliage protects the ground from the parching rays of the sun, and prevents too sudden evaporation. The waters thus retained percolate slowly through the ground, to feed the numberless springs, creeks and rivers which, in the old time, flowed perpetually.

Remove the forests! what happens? The plants that throve and flourished 'neath their grateful shade, all die; the moss withers; the parched leaves are blown away by the winds. Then comes the rainy season. Rain falls in torrents, and washes down the sides of hills and mountains, carrying off the rich mould, the deposit of ages, the life of the land; overflowing the valleys, obstructing river channels, and often destroying life and property in its resistless force. It is not difficult to see that the results arising from the denudation of hills have been, and will continue to be, disastrous.

GENERAL VIEW OF THE INTEREST NOW MANIFESTED IN THE PROTECTION OF FORESTS.

Many parts of Europe are suffering from floods more than in former generations, from causes similar to those which deluged the Ohio valley. The experience of Hungary, France, and northern Italy has been very unfortunate. Even many of the German States, although more careful in their efforts at prevention, have suffered severely.

In 1875 Herr Gustave Wex, Councillor of State, and Director of Government Works for the regulation of the flow of the Danube, in a paper read to the Geographical Society of Vienna, affirms that in the last fifty years the decrease in the average level or comparison between the highest and the lowest flow of the Rhine, has been 24 inches; the Vistula, 26 inches; the Danube, at Orsova, 55 inches. These measurements unquestionably show that the floods are higher than in former years, and the difference between the highest and the lowest levels is much greater. Many

of the manufactories have experienced great difficulties, and have been, in many instances, compelled to substitute steam for their diminished water supply.

This remarkable change in the water level of these rivers is ascribed to the clearing away of the forests, especially in the mountains, where inundations occur more frequently. The correctness of these conclusions is sadly illustrated by recent floods in the valleys through which these rivers flow.

Several learned societies, such as the Royal Academy of Science, of Vienna; the Imperial Academy, of St. Petersburg, and others, appointed a commission to report on the statement of Herr Wex, and it was substantially confirmed. The commissioners say: "Forests exercise a beneficial influence which cannot be estimated too highly, in an increased humidity of the air, a reduction of the extremes of temperature, a diminution of evaporation and more regular distribution of rainfall—while in their destruction is seen the injurious effects of an alternation of periods of drought at one time and floods at another."

Of the climatic influence of forests there can be little doubt. Many theorists claim that they cause rainfall, but I think experience will not sustain these theories. As before stated, they retain it, economise it, and distribute it more regularly, causing a more equable temperature and more humid atmosphere.

Dr. Brandis, Superintendent-General of Forests in India, in a paper on the geographical distribution of forests in India, which was read before the British Association for the Promotion of Science, considered India as divided by the rainfalls into arid, dry, and wet districts, and in the west corner of India was what might be called the arid tract. The average rainfall in this district was less than 15 inches. In this region the work of the forester was limited to those tracts that stretched along the Indus and its tributaries, watered by the annual overflow of the river during the summer, or which could be otherwise irrigated. Thus there were in Scinde 352,000 acres of Government forests maintained by the overflow of that river and by protection. The result of the deflection of a river from its course was that the forest near the old bed frequently perished.

In the southern dry zone, comprising part of the Deccan, where the ancient irrigation works, tanks and stone dams across rivers existed, vegetation was most vigorous. Dr. J. C. Brown, who is the most voluminous writer, and perhaps one of the most reliable, on the subject of forestry, in his excellent work on "Forests and Moistures," in which he shows much research, and gives a larger quantity of testimony than we find elsewhere on the subject of forests and rainfalls, says:—

"From what has been advanced, it appears to be established as a fact that there are cases in which an extensive destruction of forests has been followed by a marked desiccation of soil and aridity of climate, and some cases wherein the replanting of trees has been followed by a more complete restoration of humidity, or the planting of trees where there were none has been followed by a degree of humidity greatly in excess of what had been previously observed; that there are cases in which the rainfall within forests, or in their immediate vicinity, has been perceptibly greater than in the open country beyond; but that there are also cases in which it is alleged that because of desiccation some lands, once clothed with forests, and fertile, are now treeless and barren and dry. This may be attributed in part, if not in whole, to other causes besides the destruction of the forests; and there are cases in which the extensive destruction of forests does not appear to have extensively affected the quantity of the rainfall over a wide expanse of country.

"These facts, by a little latitude in the use of language, may be characterized as antagonistic or conflicting, but they may, nevertheless, be accepted as facts, and that, with the admission that, if facts, they must be perfectly compatible with each other, and not only compatible, but consistent with each other, in the actually existing condition of things, and necessary to be known, in order to a correct conception of this system as a whole.

"The effects of forests in retarding the flow of the rainfall, after its precipitation, has been established, I consider, beyond all question; and not less so their effect in maintaining a general humidity of atmosphere and soil."

Sir Richard Temple, Bart., in his interesting work, "India in 1880," says:—

"Many believe that the rainfall is copious and seasonable, or otherwise, according as the woods and forests and the vegetation subsidiary to them is preserved or destroyed, while others disbelieve this view, which, at all events, must admit of much qualification. But after all due statements have been made, this view is generally held to have some truth. The total rainfall of the whole country cannot possibly be affected by the forests. The average quantity of vapor must come from the ocean, and must be condensed somewhere; if it be not discharged in rain as it crosses the plains, it will pass to the mountains and be transformed there. This, indeed, is a matter of common experience; moisture-laden clouds float over the Deccan, leaving it arid, and move on to the Satpura range; and, being condensed there, fill the torrent beds with rain water, which rushes into the runs and returns ultimately to the plain, in the shape of inundations. Similarly, clouds sweep over Hindostan's thirsty plains, and being condensed in the Himalayas, return in the form of floods in the great rivers. The hope is, that if forest tracts were distributed over the plains there would be cool surfaces to attract the clouds, and arrest them, as it were, on their way."

This would be very desirable, but a residence for several years on the western side of this continent would not lead me to look for any such results. For example, in California, for about eight months in the year, there is no rain, yet the vapor-laden breezes come in every day from the illimitable Pacific Ocean. They pass across the grand forests of the Coast Range Mountains, thence over the rich and fertile valleys of Sacramento—over ice-covered peaks that glisten daily in the sun; but never, during the dry season, does a cloud dim the lustre of their glory. Nor do the valleys of Colorado and Utah, which lie to the eastward, get refreshed by showers, that ought, according to theory, to be the result of these vapors having come in contact with the snow-covered Sierras.

In South America climatic phenomena are still more remarkable. In Bolivia, west of the Andes, no rain has fallen for many years; nor has there been rain but once in the memory of the oldest inhabitant. East of the same great mountain range, on the great plains known as the Pampas, while some parts will be for years without rain, others will be refreshed with showers every day in the year.

Professor Arnold Gurgot, in a paper read before the National Academy of Sciences, to illustrate the great dryness to which the great plains of the Pampas are subject, east of the Andes and between latitudes 20 to 30 degrees south, mentions the *grand sec*, or great drought of nearly three years' duration, which occurred in the present century, and is still remembered as having cost the lives of millions of cattle, which came to die along the few river courses which retained some water, and whose bones accumulated in places where they died, just as fossil remains of creatures of an earlier zoological period are found on these same great plains.

"All signs fail in dry weather," and theory is as futile as signs. The author just quoted says:—

"It is remembered that throughout the world those regions which possess rich vegetation receive abundant rain, while those that are denuded of vegetation are rainless. It is remarkable that those regions in India which ordinarily receive rain, but which have been parched by a long drought, are plagued afterwards with immoderate rain."

The theory of Sir Richard Temple is not sound, so far as this continent is concerned. Abundant rain, if the soil is good, will bring rich vegetation, but rich vegetation will not bring rain. The Mormons, in Utah, have succeeded in covering their hills and valleys with the richest kind of vegetation, but have not succeeded in increasing the rainfall. Pizaro found in Peru hundreds of square miles of groves of lemon, orange, olive and other trees—all the result of irrigation; but the rain never came in what was known as the dry season. Last season the people of Manitoba complained of long drought, but I never saw anything to surpass the richness of the vegetation of their wheat fields and meadows, when I visited them in August last, although rain had not fallen in the part of the Province I have made reference to for over two months.

Nor would his theory be sustained by results, even in India. It has been shown that the extensive tracts of forests on the lands watered by the overflow of the Indus, never could induce clouds or rain to approach, except in the rainy season;

and large tracts perished of thirst when the river, as it sometimes did, altered its course.

DESTRUCTION CAUSED BY FOREST FIRES.

In all that has been written thus far, and in the extracts taken from authors of note, I believe it has been established that the denudation of a country by stripping it of its woods may bring irreparable calamity; but it is only fair to say that man is not responsible for all the evils. Judging by the experience we have had in this country, and in conformity with the opinions of men competent to form sound conclusions on the subject, fire has been a greater foe to the forests than man. The desolation which now overspreads Persia and other eastern and southern lands cannot all be fairly put to man's debit. These countries labored under the same climatic disadvantages that now affect every State on the west of this continent, from Oregon to Chili. They were plagued with long periodical droughts. At the close of a protracted dry season a fire might take, from no fault of man. A gale or a hurricane that was altogether beyond his control might ensue, and drive and spread the flame that would blight the fortunes of the inhabitants of a district or a province.

The great losses that have been entailed by the numerous disastrous fires that swept away many of the finest forests of America impel us to give the subject a large share of attention. Laws for the preservation of our forests and protection against their destruction have been enacted in all our Provinces, and also by the Government of the United States, and each of the individual States and Territories, and in the appendix to this report will be found copies of such enactments as seem most worthy of attention or adoption. At all events, they will afford ready assistance in the preparation of new or the amendment of existing statutes upon the subject.

Up to the present time, fire has been the greatest enemy that our forests have had to contend with. The Hon. Mr. Joly, in his valuable and very able "Report on the Forests of Canada," says: "It is estimated, by those who are competent to form an opinion on the subject, that more pine timber has been destroyed by fire than has been taken out and destroyed by the lumberman; not only is the ripe timber destroyed by fire, but all the young trees, too, upon whose growth we must depend for the restoring of our forests. It is not practicable in our Canadian woods to plant trees to take the place of those that are cut down."

The difficulty of guarding against fire in such immense and distant forests as ours is enormous, and as for extinguishing a forest fire when once fairly started, *the power of man cannot succeed*. It will sweep onward, so long as it can find food, leaping at one bound over such rivers at the great Ottawa and Miramichi, and will only stop when brought to bay by the large lakes, or when it reaches rocky or barren ground, with nothing to burn; it will riot for weeks, until starved for want of food, or drowned under torrents of rain.

We can cope with waste and pillage; they are but the works of man; but we are terribly helpless against forest fires. It is, in every country, the greatest enemy, especially of pine forest, on account of its resinous and inflammable nature. It is ubiquitous: you find it causing its ravages wherever nature has planted her grand virgin forests, in North America destroying the beautiful white pine, and at the Antipodes, in New Zealand, sweeping away the noble Kawari pine; through India, the Russian Empire, Sweden, and Norway, it throws around the world a girdle of lurid flames, only broken by the great oceans.

In France and Germany the science of forestry is brought to a high state of perfection. Where the forests are much smaller than ours, divided and isolated one from another, kept as much as possible free from rubbish and dead timber, and the light stuff that carries on the flames so rapidly; protected by stringent laws, strictly enforced for generations, watched over by large staffs of foresters, even then disastrous fires are of frequent occurrence, and they call for such an effort to suppress them as is totally beyond our power, as the following example will show:—

Considerable forests have been created within the last two or three generations in the south-west of France, and now cover large regions that were once barren heaps of sand, rolled up far inland by the action of the sea. Those forests, created

by man, now yield a large and ever-increasing revenue, are highly valued, and must be protected, one would think, as well as any forest can ever hope to be protected. Nevertheless, fires are frequent among them.

The people do there what we cannot do here, and generally conquer the fire with more or less loss. But a short description of their mode of warfare will show how utterly inapplicable it is to our circumstances, and makes us feel more than ever that our only hope is in PREVENTION.

HOW FOREST FIRES ARE DEALT WITH IN FRANCE.

In France, as soon as it is discovered that the forest is on fire (which cannot take long, where the forests are comparatively small and the country thickly settled round) the church bells ring in all the neighboring villages, and the whole population, trained by long experience, turn out with axes, spades, shovels, rakes, &c., under the guidance of acknowledged leaders. They confine their movements according to the direction of the wind and other circumstance, and dispose their forces with intelligence and promptitude. A mode often resorted to is the *coupe feu*, fighting the fire with fire, something not unlike the hunters practice when overtaken by fires on our western prairies. Knowing the forest well, they direct their forces to one of the *coupe feus*, or safety strips (upon which no trees or shrubs are allowed to grow), or to the most favorable spot on the path of the fire, at a sufficient distance ahead of it, form an extended line of workers wider than the fire, and set to work to remove the inflammable materials as much as possible. They cut down and burn and trample out or shovel earth on what they cannot carry away of the inflammable stuff, &c., and when the fire, in its course, reaches that spot, it finds little food, hesitates, lingers, and at last is generally conquered.

We cannot do that; our forests are not surrounded by villages, the alarm bells cannot muster crowds of willing workers to our distant wilderness, often hundreds of miles away from the dwellings of men.

But if we cannot stop fire, can we not do something to prevent it or to limit its ravages? The best means adopted in Germany and France, and in Great Britain, too (where the science of forestry is becoming an object of serious study), for preventing the spreading of fire over a large tract of ground, is the laying out of their forests, and dividing them into isolated independent blocks by means of safety strips or *coup feus*. But even then, whenever the wind is very strong, it has been found that it would carry inflammable matter, such as pine cones, clear over everything, to a distance of one and even of two miles, and there start fresh fires where they fall, which will be readily believed by those who remember how easily fires have swept over the Ottawa River.

Though not always sufficient, these safety strips are nevertheless of great service, but their opening with us is scarcely practicable. It would entail incredible labor and expenditure, on account of the great length we would have to prolong them and the distance; and, furthermore, the brush and the timber felled down to make them would have to be removed; otherwise it would soon dry up and increase the danger instead of decreasing it. Then, to maintain their efficiency, they would have to be kept clear of a new growth. We cannot think of undertaking such a gigantic work, at least in our large and remote forests. Neither can we undertake, as they do in Europe, to clear the underbrush and to remove the dead wood and rubbish. It is an excellent precaution, and its adoption in Europe is not only free from cost, but it brings in a large profit. Our circumstances are totally different, as any man of any experience must know, and I will not enlarge upon that point.

If we cannot profit by these good examples, we are nevertheless not going to sit tamely down and declare that nothing can be done. We can do a great deal to prevent our forests from being set on fire.

HOW FOREST FIRES ARE STARTED.

The fires are started by settlers clearing their lands; by lumbermen, while driving their timber down the stream; by hunters and fishermen; by sparks from

locomotives; by lightning; sometimes, even, by the violent rubbing of dead branches one against the other in gales of wind.

We cannot very easily provide against the latter causes, as we cannot remove all our dead wood or provide against lightning in the forests. But locomotives can keep down their sparks, with screens over their smoke stacks. The railway companies are instructed in every way in guarding against fires, and if they neglect to take sufficient precautions, they can be reached and called to account.

A frequent cause of disastrous fires in the woods is the mode of clearing land now generally adopted by settlers.

There is considerable diversity of opinion as to the total quantity or value of the timber consumed annually by fire; but it is pretty generally admitted that it is a greater source of consumption than all others combined. One gentleman, Mr. Thistle, who is a surveyor by profession, and a lumberman of long experience, puts the quantity destroyed by fire at ten times that used in the manufacture of lumber. Another, Mr. Stewart Thayne, in his evidence before a committee of the House of Commons on immigration and colonization, places the annual loss, in the Ottawa valley alone, at \$5,000,000. In view of such testimony as to the enormous loss the country sustains, it is rather strange that steps have not been taken sooner to organize a forest corps, whose duty it would be to prepare our nearest forests with fire strips, or *coup feus*, such as have been adopted in Germany and France, regardless of the cost, as in no case could it reach a fifth of what the annual loss is estimated at.

Mr. Thayne said, on the question of the appointment of a staff for the enforcement of the laws for the prevention of forest fires: "The appointment of such a staff would supply one of the most urgent needs of the country. If it were generally understood that the lowest estimate of the average annual loss through the forest fires places it at \$5,000,000 in the Ottawa valley alone, it seems to me that public opinion would soon interfere to prevent such a fearful waste of the national wealth, for it should be remembered that in the great majority of cases these fires originate from causes which could be easily controlled."

Dr. Franklin B. Hough, who acted as chief of the Forestry Branch of the Agricultural Department at Washington for several years, has gone into the subject of forest fires very exhaustively. In his report, vol. 3, he devotes no less than 130 pages to that subject alone.

In 1880 a circular was issued from the Department under his care to its correspondents in the several States and Territories, with a view of ascertaining the extent of injuries that have been sustained and observed through forest fires, the causes of these fires, so far as known, and the methods commonly employed for preventing them or arresting them when started and under way. The circular invited such suggestions as might appear advisable concerning the means for preventing the continued recurrence of these calamities.

Some of the suggestions and advice given are worthy of note, and might be adopted with advantage. One correspondent says, in answer to the request for suggestions:—

"1. Open the eyes of the people to the danger, the immense destruction of property, the rapidly shrinking streams, the increase and duration of droughts, the blighting of landscapes, and the general climatic effect. This can be done by national publications fitted for the common people, not by documentary reports. Force these upon the attention of all by tracts or placards in the places of common resort—in lumbering camps, in all centres of population adjacent to the forests.

"2. By stringent national and State laws, fastening responsibility upon careless guides and tourists, and also upon those who are clearing lands. When a man wishes to burn a fallow piece he should girdle it with swathes. Responsible men, who would not think of endangering their neighbor's house by a bonfire in their garden, think nothing of letting loose their fallow fires into adjoining timber."

The correspondents who offer suggestions almost always ask for more vigorous laws, with rewards offered for the conviction of delinquents; while others admit the existence of laws, but deplore the fact that the laws are not enforced—something, I

suppose, like our provincial law for the prevention of the spreading of the Canada thistle, which is now almost a dead letter.

The estimate of the value of property destroyed contained in the replies to the circular is incalculable, and the quantity of good forest land rendered utterly worthless is very much to be deplored.

In an appendix to this report will be given an abridged account of the most important historic forest fires that have occurred on this continent, as the reading of them will naturally impress one with the great necessity which exists for carefulness against fire.

SUMMARY OF THE CAUSES OF FOREST FIRES.

Dr. Hough gives a summary of the supposed causes (as gleaned from his correspondents) which led to the fires reported on. The summary, in numerical form, is as follows :—

Natural causes—lightning..... 3

The direct, or incidental act of man.....464

Of the latter, he says the Indians are charged with 21 cases, the remainder being ascribed to civilized man—the motive with the former, in most cases, being hostility to the whites and a desire to harm them as much as possible. In a few cases burning to drive game is mentioned.

The 443 cases for which the white man is directly or indirectly held accountable are as follows :—

INTENTIONAL.

| | |
|---|----|
| For improvement of pasture or the clearing of land, &c., &c. | 85 |
| Incendiary and malicious firing..... | 37 |
| Tramps (perhaps carelessness) | 6 |
| Back firing (for safety) | 3 |
| Clearing the ground to find nuts..... | 5 |
| Clearing the ground to find mica..... | 1 |

ACCIDENTAL.

| | |
|---|----|
| The fire escaping from brush heaps in preparing land for cultivation | 93 |
| Hunting, usually from careless neglect of camp fires or to destroy dead leaves..... | 75 |
| Careless leaving of camp fires by traders, pleasure-seekers, &c., &c..... | 69 |
| Locomotive sparks..... | 75 |
| Charcoal burning..... | 11 |
| Steam mills..... | 2 |
| Burning oil well..... | 1 |

It will be seen that fires from natural causes, according to this summary, are very rare, and that those caused by the Indian, in what he considers legitimate warfare, are few ; while those by man, intentionally, amount to over 30 per cent. ; and that 70 per cent. are attributable to carelessness, the greater part being avoidable, and if not in preventing the starting of fires, it may be seen from the above figures that provision to a great degree might be made for their suppression.

The estimates of the damage are enormous, but Dr. Hough considers them to be founded in many cases on uncertain information, and very seldom on exact appraisal. He says: " In fact, we would consider any attempt to obtain a numerical summary of the annual destruction resulting from forest fires, through any existing agency, as liable to great error, for it would necessarily be founded upon personal estimates, which would sometimes be exaggerated, from their overwhelming local importance in the immediate presence of the observer, and in other cases immensely undervalued, from their being in remote and inaccessible regions, where the only data for estimate might be a column of smoke on a distant horizon, or the vague rumors of hearsay."

Dr. Hough's compilation of facts is very interesting, but, unfortunately, goes to show how general all through the States and Territories is the destruction of the remaining woodlands of the whole country still going on.

In the organization of a system of forest management, of the immediate necessity of which there is no doubt, we shall have to seek from, and learn by, the experience of those countries that have given the subject their greatest attention, all the information that will be most valuable to us.

EUROPEAN SYSTEMS OF FORESTRY.

Germany, France, Austria, and Italy have all very mature systems. They long ago realized their danger, and adopted systems of forest management, and have never ceased in their efforts to improve them. They enacted codes and statutes for the protection of their woodlands; established schools and colleges for teaching practical and scientific forestry. France, appreciating the great benefit that resulted to herself by the improved system, extended it to her African colonies. Russia, although 42½ per cent. of her land is covered with trees, has, nevertheless, established schools for learning forestry in all its bearings, and enacted laws for the protection of her enormous forest domain.

In 1858 Baron Von Berg, a distinguished forest officer of Saxony, was requested to report on the forests and forest management of Poland and Finland, and the establishment of schools of forestry was the result of his report. In some of the schools the teaching of agriculture is combined with that of forestry.

Professor J. L. Budd, of the Iowa Agricultural College, who visited Russia last year, with a view of ascertaining which species of fruit and forest trees and shrubs would be most suitable for the climate and soil of Iowa, gives much valuable and interesting information. He says:—

"On visiting the grounds of the Agricultural College, near Moscow, for the first time, a forestry convention was assembled there. About 150 foresters—forestry managers—were present. As a class, they visited all parts of the ground, and listened like school boys to explanations of modes and methods adopted, and the reasons therefor. These open-field lessons were finished with fine-object lessons at the propagatory beds and in the forestry plots, under different management and in different stages of growth."

Mr. Budd visited many of the forest plantations. Of his visit to Julia, which is situated 200 miles south of Moscow, he says:—

"We were favored with a letter from the Minister of Public Domains to the Governor of the Province. Our visit occurred at a time fixed for a visit to one of the large forest plantations of the Province, 14 versts distant. I should say the Province of Julia is one of the smallest of Russia in Europe, and it has little timber of native growth; but it has seven large Government plantations, ranging in size from 18,000 to 21,000 acres each. During each season the seven directors of these forests meet the general director, or governor, at each forest in succession. The object is to compare notes and to arrange for changes, or new modes and methods. An afternoon and evening with the head forester of the Province, and a stroll through the many species of trees planted forty years ago, gave us quite a clear idea of some things relating to the system of forestry that we did not gather at the great convention in Moscow. For instance, Russia has 762 large Government forestry stations, under the general charge of an equal number of educated directors, most of whom are college graduates, who have taken lessons in the forestry schools in a post-graduate way. These forests contain 300,000,000 of acres. These are divided into 12,502 named forests, which are under 762 directors. A part of these Government forests, in the north, were of native growth, but all of the central and southern Provinces have immense plantations of trees best suited to the somewhat varied steppes. In some places the plantations are almost exclusively of Scotch pine; in others, of oak, birch, basswood, elm, &c., &c. Mixed planting is not considered best, as a rule.

"In the steppes the planting has been done with the main idea of modifying the climate, and new stations are now being organized in portions where the present rainfall is only 6 inches per summer, and even drifting sands are now being planted

with *salix centifolia* (Caspian willow), to be followed, as soon as the surface is covered, with Riga pine."

"It is well that the Government are awake to this prairie planting, as the people destroy but never plant; and nothing can convey the idea of utter desolation more fully than a ride over these Russian steppes."

Much as has been done in Russia, forestry is still very imperfect, but they are making rapid strides in improving their system.

The schools of forestry in Germany have exercised a remarkable influence on the people, diffusing amongst them a great interest in forestry and arboriculture. They have a great love for nature, and delight in frequenting their beautiful groves and parks, that are to be found near every German town and city. The rural and suburban adornments, now the pride of so many beautiful towns, are largely due to the influence of the literature and training of the schools of forestry.

The history of schools of forestry goes back, in Germany, more than a century, and there we find the best endowed, and, in some respects, the best managed institutions of this kind everywhere. There are at present nine such establishments in the German Empire, viz., two in Prussia, and one each in Bavaria, Saxony, Wurtemberg, Baden, Hesse-Darmstadt, Brunswick and Saxe-Weimar.

In all the principal countries in continental Europe the woodlands belonging to the Government, to local municipalities and public institutions, are under the care of a special branch of administration, which not only looks after their management, to prevent injuries or waste, but has for its special duty the restoration of forests when out at maturity, or at appointed times, and this by means which should most effectually secure the greatest possible benefit. This management requires a well organized staff of agents, properly adapted to the duties of their profession. All these agents have been educated at forestry schools, where every branch of science essential to the cultivation and care of woodlands is taught, and illustrated by excursions into the forests, and by practical labor in the nurseries and plantations connected with the establishment. Students at these schools have their attainments tested on entering and upon leaving, as well as at various stages of their progress, and at the end of the prescribed course they may, upon successfully passing their examination, enter into the forestry service in a subordinate grade, from which they may rise to more important stations.

The range and extent of the course and a list of the professorships, and of the studies taught by each, in the Forestry Academy, at Tharanadt, in Saxony, will illustrate what the student has to study.

Dr. Hough says of this academy: "The student must show, upon entering, besides certain qualifications as to age, means of maintenance, &c., the attainments implied in a full course of study at a gymnasium or a "Real Schule," and if he aspires to the Saxon service, he must have worked half a year, under approved instruction, in a forest.

"The course is divided among ten instructors, as follows:—(1) The director, who teaches the history and literature of forestry, forest regulations and improvement and police, and leads in excursions and practical exercises; (2) a professor of arithmetic, algebra, and geometry, and their application to forest work, and mechanics, accompanied by mathematical exercises; (3) a professor of chemistry and chemical technology, agricultural chemistry and laboratory work; (4) a professor of physics, mineralogy and geology, who leads excursions in the application of these studies; (5) a professor of forest cultivation, protection and administration, hunting and forest taxation, with practical excursions and exercises; (6) a professor of forestal and general botany, and vegetable physiology, and microscopy, with exercises and excursions in natural history; (7) a professor of surveying, road-making, draining, the calculus, &c., with excursions in surveying and measuring; (8) a professor of general forest industries, forest finance, and an encyclopedic view of agricultural pasturage, &c.; (9) a professor of zoology, and especially of entomology; and (10) a professor of law and forest jurisprudence."

The academy at Tharanadt is exclusively devoted to forestry in its fullest comprehension.

At Hohenheim, the Royal Wurttemberg Academy is a school both of agriculture and forestry. The Hon. B. G. Northrop, Commissioner from the State of Connecticut, who recently visited this and other celebrated forest academies, says: "Its immense edifice, formerly a summer residence of the Wurttemberg kings, is delightfully situated on a very high ground, nine miles from Stuttgart. Near the building is a fine park and experimental botanic gardens, groves, and arboricultural nursery. The botanic garden, covering over 12 acres, contains some 2,000 species and varieties of plants, important in forest and naval economy, and an exotic garden of 20 acres, specially adapted to forest botany. Near by, upon the same mountain range, is a forest district of about 6,000 acres, embracing a variety of soil and trees. The institution has an extensive collection of implements used in practical forestry, with models of machines and studies pertaining thereto; a museum of forest products, and herbarium, containing over 10,000 species, and a very interesting collection of microscopic preparations, more extensive than I had elsewhere seen, with a various collection of pathological specimens, illustrative of diseased malformation, and some 7,000 specimens of fruits and seeds. Great varieties of fine wood, showing the texture and grain, are exhibited in the museums of all forest schools, but this one is a remarkable collection of 'microscopic specimens,' transverse sections of wood, thin as the finest paper, arranged in books, as photographs, are set in the spaces of an album. Held up to the light, these thin sections are translucent, almost transparent, and show the most delicate shades in the grain of the wood. Here is also a collection of noxious insects, and all animals harmful to trees. The insects are shown in all their progressive states—as eggs, larvæ, pupa, or chrysalis, caterpillar, and moths, with their nests and perforations in the stems or branches, and with samples of the trunk, bark, branch, root, leaf, cone, or fruit, both sound and injured. For a careful comparison, the healthful and diseased specimens are placed side by side.

The curriculum fills two years, and in the forest department embraces, among others, the following topics:—Forest economy; history and literature of economy; forest produce; sylviculture; forest protection; technical properties of timber; uses of forests, and forest technology; forest administration, including mensuration of trees and forests; partition of forests, for exploration; valuation of forests, and practical management of forests; forest excursions in different forest districts; botanic garden and museum of forest products; cubic measurement of trees and cubic contents of wood; land surveying and levelling, and mensuration of forests with theodolite.

For board, lodging and tuition, the native students pay about \$40 per annum, but foreign students are charged about \$120. Many foreign (especially English) students attend these academies, and Mr. Northrop says: "Dom Pedro appreciates the national importance of forestry in Brazil. I was much interested in an intelligent and ambitious young Brazilian, who is here training himself for a forest appointment in his native country."

A striking illustration of the influence of forest schools is seen in the number of works on forestry that are published in the country. Most of these have emanated from the professors and graduates of these schools, and there are catalogues of over 2,500 volumes on the subject of forestry, tree culture and botany, and over one hundred new books appear annually in the German language; while the literature in the Spanish language, on the same subjects, amounts to about 1,200 volumes. There are also published, in both these languages, very able journals, devoted to the subjects we have noted. I regret much that the works in the English language are very few, and that the only periodical in America "The American Journal of Forestry," devoted to the interests of forestry, has been obliged to suspend for want of sufficient encouragement.

One of the oldest and best schools of forestry in Europe is at Nancy, an old and very interesting city of France, in the department of Meurthe. The city is beautifully situated on the bank of a river, at the foot of a long range of wooded and vine-clad hills. Both the city and department are noted for their rare rural beauty, and they owe much of this to the influence of the famous school, which is now very liberally supported, and is very complete in all its appliances.

Instruction is given gratis to those who prepare for the State forest service, the importance of which may be inferred from the fact that the State forests cover about

three millions of acres of land, with a gross revenue of about seven millions of dollars a year, or deducting expenditure, a net revenue of about five millions of dollars a year. A good many English students, who were preparing for service in the forestry department in India, were graduates of this class of 1881. The expense for uniform, tuition, &c., is about \$500 per year. The course occupies three years, of about ten hours daily work.

In winter, the session lasts from 1st November to 1st of May. Seventy-five lectures, of one hour and a-half each, are given on forest economy, and the same amount of time is allotted for the preparation of the subject of each lecture. The course comprises the exploration of forests, relation of forests to climate, natural history of different kinds of trees, management of forests, conversion of one form of forest into another, and desirable qualities and defects of woods. The same number of lectures and the same amount of study are devoted to botany—the structure, organs, physiology and geographical distribution of plants. Of the seventy-five lectures on mathematics, twenty are devoted to land surveying and levelling; fifteen are given to the preparation of plans, under a professor. There are lectures on road and bridge-building, such as may be required in forest exploration; on forest law, and on the German language, together with instruction and drill, and practice in horsemanship.

Of the summer session, which extends from 1st May to 1st September, thirty days are given to excursions into the mountain forests of the Jura, Vosges, and other ranges in which trees and shrubs are seen in all stages of treatment, and the student has practical lessons in the measurement of wood and trees. Six days are occupied in preparing a report of the tour of observation. Seven days are given to the making of diagrams, with report, calculations and topographical plan, including levels, with drawings of the same. Time is also given to the study of imaginary projected roads, with drawings and specifications, and estimates relating to embankments, masonry, &c., &c. About a week is devoted to military tactics, comprehending shooting and sketching. Land surveying is also a prominent study during the summer term.

In the second year the courses vary some, and are more extensive. The season for cutting timber; the ages of the different kinds of trees to be felled; the proper time for a revolution of forest crop and its restoration; mineralogy, lithology, and the geological features of the country explored. Saw mills, gauging, water courses, mill dams, water wheels, and the time required in the work of sawing, are all included in the course of studies.

In the winter course of the third year, the advanced student, in addition to the branches already enumerated, takes in zoology, with special attention to entomology, the ravages committed by insects upon forests, the means of recovering of forests thus ravaged, the reclaiming of barren wastes and the re-foresting of denuded mountains, and the best means of preventing or lessening damage from mountain torrents.

We shall notice one more of the great forest schools of Europe, the far-famed Vallambrosa (shady valley), formerly a Benedictine monastery, founded in 1070 by St. John Gualberto, and which was visited by Milton, in 1637. It is beautifully situated in a valley of the Apennines, about 20 miles from Florence, and overlooks the lovely scenery of the Val d'Arno. The present magnificent buildings were erected in 1637 by Pope Urban VIII. Besides Milton, Byron, Dante and other poets loved the inspiration of the lovely groves, many of which had been planted by the monks, centuries ago, who understood well the economic value of tree planting. Professor Northrop, who visited the place lately, says: "It is due to their sagacity and foresight that those vast lands are now densely covered with pines, larch and chestnut. The very position of the trees, standing in exact rows, shows that tree planting on a large scale has been here successfully carried on for centuries. The property was appropriated by the Italian Government in 1865, and opened as a school for forestry in 1869, by royal decree. The system is not essentially different from that of Nancy, and the institution is under the direction of Senor Adolphe de Bérenger, Director-General of Waters and Forests."

Italy has experienced the injurious effects of forest denudation, in spring torrents and a great diminution in her water-courses, so essential to her fields for irrigation.

For some time there was considerable discussion as to whether forestry schools should be isolated, or connected, as an additional department, with existing universities or other institutions of a more comprehensive character. This was a prominent question for discussion at the Congress of Foresters held at Friburg, in Baden, and attended by about 400 members, representing all parts of Germany, Switzerland, Austria and Russia. Leading writers on forestry were there, as well as leading Government officials in the management of forests.

The president of the convention was Dr. Naulinger, the eminent Professor of Forestry at Hohenheim. The discussion awakened great interest and lasted over six hours.

A brief summary of the leading arguments shows the feasibility of connecting a department of forestry with established universities, schools, or colleges. I quote from Mr. Northrop's report:—

"The discussion was opened by Professor Danokolmann, of Eburwald, in Prussia, defending the separate 'Forester Akademie.' He contended that universities are intended to aid thorough investigation in the abstract rather than in the concrete. Though rich fountains of knowledge, they do not teach practical skill. The forest academies, on the other hand, keep the practical ever in view, and the attainment of knowledge is always combined with practice. Four things are essential: First, instruction in the technical work of forests; next, in the management of forests; thirdly, in scientific researches; and lastly, in the practical application of theories. Special schools are best fitted to secure these results. The 'Hochschulen' are located far away from any forest, and the professors are therefore less acquainted with practical forestry, and the students, though more varied in their attainments, will fail to know thoroughly the things most essential to their profession; they will remain strangers to forests, and will not learn how to question trees; they may see cases of dead insects, and yet learn nothing of the lives and habits of insects. To be a means of instruction, the forest must be a demonstration ground, and should be so situated that it can be visited daily without fatigue or expense. Though the university is the centre of culture and aristocracy, each of these is of secondary importance in the training of forest technology. The professors of the accessory sciences are out of sympathy with, and busy themselves with problems, irrespective of their relations to forest science. If it be said that the universities have produced more eminent thinkers and writers than the forest academy, the remedy should be found in the academy, and in the enlargement of its course of studies, with opportunity for the student to resort to the forest every day, proposing and solving his questions on vegetable physiology and zoology."

The speaker who opened the discussion on the other side, Dr. Von Seckendorf, from Vienna, attributed the origin of isolated schools of forestry to the former state of forests, and the limited education required for forest service in a bygone day. But now a more scientific method of research in forest matters has been introduced, and a higher testing examination is demanded of students in forest science. A liberal education is essential here as well as in other professions. The advocates of separate schools of forestry claim two points of special superiority.—First, that their students are better trained in practical forestry; and, second, that in these only are the studies conducted with due reference to the requirements of the forester. They assume that in the vicinity of the university there are no forests suitable for the proper instruction, and that a purely theoretical education must only here prevail. The assumptions are unfounded:

The number of university and 'Hochschule' towns in Germany richly surrounded with woods is very great. It is not the extent of a forest which decides its suitability as a means of instruction so much as its variety of trees and modes of treatment and exploration.

The second assumption will not bear examination. Science and practical work are not antagonistic to each other. In the universities instruction does not go beyond what is desirable for the educated man. And there ought to be no grounds for the suspicion that any students of forestry choose that department because it makes the

least demand upon them. Situated near railways, the universities have the best facilities for forestal excursions and fullest demonstrations in the field. As a matter of fact, the special schools do not turn out more practical men, and are not supplied with better districts for excursions; while, on the other hand, in the Allgemeine Hochschulen the instruction in the necessary science can be more complete and extended, and be given at no additional expense to the State.

After a long and lively discussion, on a vote being taken, it was shown that a majority were in favor of combining forestry with other departments in the university or 'High Schulen.' It will be seen by this that the latest experience in Europe is in favor of organizing a forest department in connection with some existing collegiate institution.

In Spain, Portugal, Denmark, Norway and Russia, forestry schools are mostly in connection with schools of agriculture. The standard of education in these latter countries for students of forestry, is not so high as in the former.

In Sweden, also, a system of forest education has been established on a very liberal scale, although over 40 per cent. of the country is covered with valuable forests.

FORESTRY IN INDIA AND AUSTRALIA.

In India steps are being taken to organize a system of forest schools. Owing to the dense population who, from time immemorial, enjoyed rights of usage in cultivation and pasturage, wholly inconsistent with successful forest culture, and whose ancient prejudices had to be respected, and various abuses conciliated and overcome, the Government, at the outset, found itself surrounded with difficulties that seemed insuperable. These difficulties were grappled with and surmounted, and after ages of improvidence, waste and destruction have been arrested. A forestry department has been established, and the Government has sent students, at the expense of the State, to France and Germany, to learn the most improved systems of forestry, as taught in the schools of these countries.

There are now sixty millions of acres of forests under supervision and control of the forestry department, with a net revenue of over a million and a quarter of dollars per annum.

As soon as the heavy outlay for surveys and plantations, essential in the first stage of the work, is lessened, the net revenue will greatly increase.

In South Australia, for many years, the woods and forests had been under the control of a board of supervisors, but recently their management has been transferred to a department, under the Commissioner of Crown Lands. At the end of the last year there were nineteen forest reserves in a most satisfactory and prosperous condition. In fact, in the matter of forest conservancy, South Australia displays the most systematic and rapid progress of any portion of Her Majesty's dominions. The old board was comprised of gentlemen who took a deep and intelligent interest in the work committed to them. The report for 1880-81 is now out, and in it may be seen the results of the skill and indefatigable zeal of the officers in charge of the works. Much progress has been made, and large areas have been planted with suitable trees, many of which are exotic. It is also stated that farmers and land owners in the colony are giving much attention to the subject, encouraged by the excellent example of the Government. It is believed they will find a profitable mode of investment.

Many interesting details of the work in progress, and excellent suggestions regarding the future management of the forests, are given in the report by the conservator of the forests, J. E. Brown, F.L.S. There are nineteen forest reserves, comprising a united area of 239,336 acres.

There are four well-established nurseries in connection with the department.

Planting and other conservancy operations have been conducted on eight reserves.

The revenue from the plantations during the past six years has been in excess of the expenditure.

The long season of drought which occurs yearly in Australia is very detrimental to tree planting, and it is only with diligence and great care that success is possible,

It is hoped that when a reasonable proportion of the acreage of the colony is covered with trees that the climate will be much ameliorated.

The other Australian colonies, following the good example set by the Government of South Australia, are now devoting much attention to the conservancy and protection of forests. What success may have attended their efforts I have not been able to ascertain.

The physical history of every country proves that a reasonable extent of forest promotes, in a high degree, both its agricultural and manufacturing interests, as well as the productive resources of the country at large, and the beneficial influence of the forests, in a physical, economical, and healthful aspect, is now receiving more of that attention which its importance deserves.

PROPER EXTENT OF FORESTS.

The next question which suggests itself to us is, what proportion of a country should be occupied by trees?

Economists claim that from 25 per cent. to 30 per cent. of a country ought to be covered with trees. This, of course, varies with the position, climate, physical character, and commercial interests of a country. A country with a humid atmosphere has not the same need of forests as one that is dry and arid. Then there are some districts of country that are not suitable for any other purpose than timber raising, and others which are of little value for agricultural purposes, and that might be advantageously used for the purpose of tree planting. Countries thus situated might increase the percentage of their forests as they like, but it is generally conceded that no country should have less than one-fifth of its land in forests.

The following table, obtained from most reliable statistics, shows the proportion of woodland in the different countries, as estimated at the various dates:—

| Date. | Country. | Total Acreage. | Acreage in Forests. | Percentage. |
|-------|-----------------------|----------------|---------------------|-------------|
| 1870 | Norway..... | 77,527,786 | 17,200,000 | 22.30 |
| 1872 | Russia in Europe..... | 1,244,367,531 | 527,428,510 | 42.38 |
| 1874 | France..... | 130,675,286 | 20,641,963 | 15.79 |
| 1874 | Italy..... | 73,187,335 | 9,031,310 | 12.34 |
| 1875 | Austria..... | 74,176,000 | 23,284,174 | 31.40 |
| 1875 | Hungary..... | 68,799,000 | 19,425,000 | 28.24 |
| 1875 | Sweden..... | 100,514,926 | 40,636,883 | 40.43 |
| 1876 | Denmark..... | 8,571,929 | 334,474 | 4.25 |
| 1876 | Prussia..... | 85,834,703 | 20,047,074 | 23.35 |
| 1877 | Great Britain..... | 55,802,300 | 2,187,078 | 3.92 |
| 1877 | Ireland..... | 20,527,196 | 328,413 | 1.26 |
| 1881 | United States..... | 2,095,600,000 | 773,346,000 | 35.00 |
| 1881 | German Empire..... | | | 25.04 |
| | Ontario (about)..... | | | 33.00 |

The estimate which gives Ontario 33 per cent. is, I think, excessive. It is taken from the report of the agricultural commission, and they relied upon the returns of the assessors. In Ontario it has been customary to assess bush land much lower than cleared land, and under such circumstances, lands not entirely fit for cultivation are returned as bush lands. Assessors, as a rule, do not go over a farm to find out for themselves; and the small remuneration which the township assessor gets would not encourage him to make stricter investigations.

As before stated, there are no data that enable us to estimate the extent of our Dominion forest lands. The magnificent primeval forests of Ontario, Quebec and New Brunswick, are in a very reduced condition, as far as known, and it is a well recognized fact, that as one advances towards the arctic circle, trees become stunted, until they finally turn scrubs. In our newly acquired territory in the North-West

there is an acreage of about 390,000,000 of fertile land, almost entirely destitute of trees. The area of the United Kingdom is only equal to about one-fifth of these lands, and it has been estimated that they are capable of maintaining, in comfort, an industrious population of over 120,000,000 people, that number being equal to the combined population of Germany, France, Italy and Spain, in 1871, and the acreage of land much greater than that of all these States.

The climate of this vast territory is one of the healthiest in the world; but it is very dry, and ought, therefore, to have a large proportion of its acreage in woods. Woods would have a most beneficial and ameliorating effect on the climate. They would temper the cold winds of the spring, and retard autumnal frosts. It is a well-established fact that the atmosphere of the woods in summer is much cooler as well as moister, during the day, than in open field, and that the reverse is the case during the night. As soon as the sun's rays leave the surface of the earth it chills very rapidly, and often, in a dry climate, while the air at say 5 feet from the ground is moderately warm, the temperature of the earth is chilled by radiation, and often goes below the freezing point, while the air at an elevation of 5 or 6 feet is several degrees warmer. The presence of woods would often arrest these early frosts, more especially if the woods occupied the higher grounds. The moist, warm air from the woods would spread out over the fields, after the sun had gone down, and act as a protecting mantle to the unripe crops, and thus become the means of arresting what otherwise would be an almost certain danger.

Professor John Tyndal made some very interesting experiments on radiation—and in a discourse or lecture recently delivered at the Royal Institute, in London, gave his hearers the benefit of a description.

I shall, in the professor's own words, give such parts of his discourse as sustain the theory of the difference at the earth's surface and at 4 feet above it. He says:

"I wished much to instruct myself a little by actual observation on this subject, under the open sky, and my first object was to catch, if possible, states of the weather that would enable me to bring my views to a practical test. About a year ago a little iron hut, embracing a single room, was erected for my benefit, upon the wild moorland of Hind Head. From the plateau on which the hut stands there is a free outlook in all directions. Here, amidst the heather, I had two stout poles fixed firmly in the ground, 8 feet asunder, and a stout cord stretched from one to the other. From the centre of this cord a thermometer is suspended, with its bulb 4 feet above the ground. On the ground is placed a pad of cotton wool, and on this cotton wool a second thermometer, the object of the arrangement being to determine the difference of temperature between the two thermometers, which are only 4 feet apart.

"Permit me, at the outset, to deal with the subject in a perfectly elementary manner. In comparison with the cold of space, the earth must be regarded as a hot body, sending its rays, should nothing intercept them, across the atmosphere into space. The cotton wool is chosen because it is a powerful radiator. It pours its heat freely into the atmosphere, and, by reason of its flocculence, which renders it a non-conductor, it is unable to derive from the earth heat which might atone for its loss. Imagine the cotton wool thus self-chilled. The air in immediate contact with it shares its chill, and the thermometer lying upon it partakes of the refrigeration. In calm weather the chilled air, because of its greater density, remains close to the earth's surface, and in this way we sometimes obtain upon that surface a temperature considerably lower than that of the air a few feet above it. On the other hand, the earth's surface, during the day, receives from the sun more heat than it loses by its own radiation, so that when the sun is active the temperature of the surface exceeds that of the air.

"These points will be best illustrated by describing the temperature for a day, beginning at sunrise and ending at 10:20 p.m., on the 4th of March.

"The observations are recorded in the annexed table; the elevation of the place is 850 feet above sea level; the sky is cloudless, with a hoar frost and a light north-east wind. The first column in the table contains the time at which the two thermometers were read. The column under "Air" gives the temperature of the air; the column under "Wool," gives the temperature of the wool; while the fourth gives the difference between the two temperatures. It is seen at a glance that from

sunrise to 9:20 a.m. the cotton-wool is colder than the air; at 9:30 the temperatures are alike. This is the hour of intersection, which is immediately followed by inversion. Throughout the day, and up to 4 p.m., the wool is warmer than the air. At 4:5 p.m., the temperatures are again alike; while, from that point downwards, the loss of terrestrial radiation is in excess of the gain derived from all sources, the refrigeration receiving a maximum at 7:30 p.m., when the difference between the two thermometers amounted to 10° Fahrenheit.

"When the observations are continued throughout the night the greater cold of the surface is found to be maintained until sunrise, and for some hours beyond it. Had the air been perfectly still during the observations, the nocturnal chilling of the surface would have been in this case greater; for you can readily understand that even a light wind sweeping over the surface and mixing the chilled with the warmer air, must seriously interfere with the refrigeration.

COURSE of Temperature, 4th March, 1883.

| Time. | Air. | Wool. | Difference. |
|--------------------------|----------|----------|-------------|
| | Degrees. | Degrees. | Degrees. |
| 6.50 a.m. (sunrise)... | 31 | 25 | 6 |
| 7.20 " | 32½ | 24½ | 8 |
| 8.05 " | 35 | 27 | 8 |
| 8.20 " | 35 | 30 | 5 |
| 9.15 " | 40 | 38 | 2 |
| 9.20 " | 41 | 40 | 1 |
| 9.30 " (intersection)... | 41 | 41 | 0 |
| 9.40 " (inversion)... | 41 | 42 | 1 |
| 10.15 " | 42½ | 45 | 2½ |
| 11.00 " | 45 | 52 | 7 |
| 11.30 " | 47 | 55 | 8 |
| 12.00 noon | 50 | 59½ | 9½ |
| 12.30 p.m. | 50 | 58½ | 9½ |
| 1.00 " | 50 | 57½ | 7½ |
| 2.00 " | 49 | 60 | 11 |
| 2.30 " | 48 | 58 | 10 |
| 3.00 " | 49 | 56 | 7 |
| 3.30 " | 48 | 52 | 4 |
| 4.00 " | 47 | 48 | 1 |
| 4.05 " (intersection)... | 47 | 47 | 0 |
| 4.10 " (inversion)... | 47 | 45 | 2 |
| 4.15 " | 47 | 43 | 4 |
| 4.30 " | 46 | 41 | 5 |
| 7.00 " | 35 | 26 | 9 |
| 7.30 " | 35 | 25 | 10 |
| 8.30 " | 34 | 24½ | 9½ |
| 9.40 " | 33 | 24½ | 8½ |
| 10.20 " | 32 | 24 | 8 |

Wind from north-east; stars very bright.

"Various circumstances may contribute to lessen, or even to abolish the difference between the two thermometers—haze, fog, cloud, rain, snow, are all known to be influential. These are visible impediments to the outflow of the heat from the surface; but we have now to deal with the most powerful obstacle to that outflow, to which reference has been already made, and which is entirely insensible. The pure vapour of waters, for example, is a gas as insensible as the air itself. It is everywhere diffused through the air, but, unlike the oxygen and nitrogen of the atmosphere, it is not constant in its quantity. We have now to examine whether meteorological observations do not clearly indicate its influence on terrestrial radiations.

"With a view to this examination, I will choose a series of observations made during the afternoon and evening of a day of extraordinary calmness and serenity. The visible condition of the atmosphere at the time was that which has hitherto

been considered most favorable to the outflow of terrestrial heat, and therefore best calculated to establish a large difference between the air and wool-thermometer. The 16th of last January was a day of this kind, when observations recorded in the annexed table were made.

"January 16.—Extremely serene; air almost a dead calm; sky without a cloud; light southerly wind:—

| Time. | Air. | Wool. | Difference. |
|-----------|----------|----------|-------------|
| | Degrees. | Degrees. | Degrees. |
| 3:40 p.m. | 43 | 37 | 6 |
| 3:50 " | 42 | 35 | 7 |
| 4:00 " | 41 | 35 | 6 |
| 4:15 " | 40 | 34 | 6 |
| 4:30 " | 38 | 32 | 6 |
| 5:00 " | 37 | 28 | 9 |
| 5:30 " | 37 | 30 | 7 |
| 6:00 " | 36 | 32 | 4 |
| 6:30 " | 36 | 31 | 5 |
| 7:00 " | 36 | 28 | 8 |
| 7:30 " | 35½ | 28 | 7½ |
| 8:00 " | 35 | 26 | 9 |
| 8:30 " | 34 | 25 | 9 |
| 9:00 " | 35 | 27 | 8 |
| 10:00 " | 36 | 28 | 7 |
| 10:30 " | 35 | 29 | 6 |

"During these observations there was no visible impediment to terrestrial radiation. The sky was extremely pure; the moon was shining; Orion, Pleiades, Charles' Wain, including the small companion star at the end of the shaft, the north star, and numbers of others, were already visible. After the last observation, my note book contains the remark: 'Atmosphere exquisitely clear; from zenith to horizon, cloudless all around.'

"A moment's attention bestowed on the column of difference in the foregoing table will repay us. Why should the difference at 6 p.m. be fully 5° less than at 5 p.m.? And again, 5° less than at 8 p.m. and at 8.30 p.m. respectively? There was absolutely nothing in the aspect of the atmosphere to account for the approach of the two thermometers at 6 o'clock—nothing to account for their subsequent divergence from each other. Anomalies of this kind have been observed by the hundred, but they have never been accounted for, and they did not admit of explanation until it had been proved that the intrusion of a perfectly invisible vapor was competent to check the radiation, while its passing away re-opened a doorway into space."

It will be noticed that the wind, during the observations recorded in the above table, was light south-westerly, and therefore charged more or less with vapor from the Atlantic. On the 10th of December, while the wind was in an opposite direction, he made another series of observations. "At 8:5 a.m. the two thermometers were taken from the hut, having a common temperature of 35°. The one was rapidly suspended in the air and the other laid upon the wool. I was not prepared for the result. A single minute's exposure sufficed to establish a difference of 5° between the thermometers, and an exposure of five minutes a difference of 15°; while, after an exposure of ten minutes, the difference was found to be no less than 17°." Here follow some of the observations:

December 10.—Deep snow; low temperature; sky clear; light, north-east air.

| Time. | | Air. | Wool. | Difference. |
|-------|------|----------|----------|-------------|
| | | Degrees. | Degrees. | Degrees. |
| 8:10 | a.m. | 29 | 16 | 13 |
| 8:15 | " | 29 | 12 | 17 |
| 8:20 | " | 27 | 12 | 15 |
| 8:30 | " | 26 | 11 | 15 |
| 8:40 | " | 26 | 10 | 16 |
| 8:45 | " | 27 | 11 | 16 |
| 8:50 | " | 29 | 11 | 18 |

Professor Tyndall continues: "I will limit myself to citing one other case. On the evening of the 31st of March, though the surface temperature was far below the dew point, very little dew was deposited. The air was obviously a dry air. The sky was perfectly cloudless, while the barely perceptible movement of the air was from the north-west. At 10 p.m. the temperature of the air thermometer was 37°, that of the wool thermometer being 20°, a refrigeration of 17° being therefore observed on this occasion."

These experiments show most remarkably an extraordinary difference of temperature within a space of 4 feet above, and at the earth's surface, and will, to some extent, account for what has often been inexplicable—the blighting of fields of grain while thermometers indicated a temperature considerably above the freezing point. The drier the atmosphere the more liable are we to this remarkable refrigeration of the earth's surface; consequently, the greater and more imperative the necessity for planting forest trees on our North-West plains. The earth is covered with a screen of aqueous vapor; this screen is densest near the equator; at the sea level it diminishes as altitude and latitude increase. It is, however, claimed that the presence of large bodies of woods store up the warm, humid atmosphere during the hours of sunshine; and at night they mingle this with the dry atmosphere of the adjoining plains, preventing such results as the observations of Professor Tyndall exhibit.

NECESSITY FOR TREE-PLANTING ON OUR PRAIRIES AND PLAINS.

Of the great necessity of tree-planting on our prairies and plains there cannot be a particle of doubt. Fuel and shelter are among the first wants of the settlers. With these wants supplied, the country would be all that could be desired to make a people happy, healthy, self-reliant and respected.

Some scientists say that the character of the soil of the high plains is such that trees will not grow thereon; but the experience of the pioneers of the adjoining Territories and States affords promise of unquestionable success. In Dakota, Iowa and Nebraska the condition of soil, climate and physical aspect resemble, in a remarkable degree, those of our prairie lands; and, more than that, there are good grounds for believing that all these plains were once covered with forests; that they are treeless because the Indians, taught by their necessities, made it a practice to burn the grass annually, which made the growth more luxuriant, and consequently more inviting to the vast herds of buffalo on which they depended greatly for their subsistence. It has been conclusively settled that no herb but buffalo-grass will grow on ground over which fire has passed until another season, so that the yearly prairie fires spread over the plains until they became almost measureless in their extent.

The Indians have a tradition that it was only after the introduction of the horse that prairie burning began. The horse progressed gradually from Mexico towards the north, and the burning of the forest was resorted to in order to secure good

hunting grounds, and that fires were kindled annually to make the pastures more attractive to buffalo and other large game.

Mr. Mechan cites several instances where trees had grown again, when fires had been discontinued.

Dr. Robert Bell, in the Geological Report for 1875, says:—

"Bearing upon the question in reference to the formation of prairies, and the causes which prevent them from becoming covered with trees, I may mention the fact that on the second steppe, at least, the character of the soil, locally, has an important relation to the wooded or open conditions which we find prevailing at the present time. In this region the distance of trees seems to depend upon the capacity of the soil for recovering and retaining the proper amount of moisture. The clayey loam of the Touchwood Hills supports a continuous, thick and strong growth of trees; whereas the gravelly and sandy soil of the surrounding country produces little more than scattered clumps of aspens and willows. On entering the Five-Mile Woods in the Severn valley, the change from light sandy to a stiff, clayey soil, is at once observable. The belt of heavy timber which I passed through between Big Boggy Creek and the upper part of the Shell River corresponds with a stronger soil, and, generally, in the Duck Mountain region, where the country presents a mixture of prairie openings and woods, the former correspond with the lighter, and the latter with the stronger soil. Another instance of a thick growth of trees upon a clayey area is found in the Bad Woods, near the western boundary of Manitoba, on the middle trail to Fort Ellice, and many more examples might be mentioned. Conversely, the drier sand and gravel areas are usually devoid of timber, although the depressions among the sand dunes and ridges seem to be the favorite habitat of the scrub oak. Near Fort Ellice, the bouldery clay of Beaver Creek, and of the north-facing slopes of the Calling River, are thickly covered with poplars, while the gravelly and sandy area above the banks, stretching for some twenty miles to the west, and fifty to the north, is destitute of timber, except here and there, where some local change allows the trees to take root. The gravelly and sandy plain to the north side of Fort Pelly, and the set of open ridges, of which Beautiful Plain is one, are similar examples. The geological history of the lowest steppe has probably been different from that of the others; yet, even here, examples of conditions resembling the foregoing are not wanting. On both the second and third steppes the northern slopes of valleys are wooded, while those facing southward are quite bare. The banks of the Calling River form a good example of these conditions, which are, no doubt, due to the influence of the sun—first, in melting away the snow in the early spring, and afterwards in parching the bank during the summer; while on the northward slope sufficient moisture is obtained to admit of the growth of trees. Although the surface of the barren, treeless district along the foot of the Coteau, from near the head of the South Saskatchewan to the head waters of the Souris River, consists of clay instead of sand, the absence of timber here also is due to the same cause, namely, want of sufficient moisture. The surface of the ground is here formed of the almost undisturbed stiff clay or marl of the tertiary formation, which resists the water, and is incapable of retaining, throughout the hot, dry summer, any moisture which might enter it during the winter or spring. As a consequence, the ground has become deeply fissured and baked as hard as unburned bricks."

The character of the soil and the condition under which trees were found growing by Dr. Bell are similar to those found south of the boundary line, in Dakota and Nebraska. There is no doubt, however, if we may judge from the experience which has been obtained south of the 49th parallel, that with proper care and due attention to the requisite protection from weeds, cattle and fire, trees will grow well on these sand dunes and gravelly hills, that are not much use for anything else.

One of the greatest barriers to success is the want of moisture. The hills of these rolling prairies, in their normal condition, shed the water like a house roof, often causing floods in the valleys and declivities that are dangerous to the lives of unwary travellers.

Some ten years ago a detachment of American soldiers were encamped in a dry creek in Western Kansas. During the night a heavy rain fell. The water in the creek and runs rose so rapidly that the men had to decamp and run for their lives.

Unfortunately, six of them perished in the flood that overwhelmed them. The waters subsided almost as rapidly as they rose, having all run off without moistening the parched earth to any perceptible extent.

As soon, however, as these prairies are broken up, so that the rains can penetrate and remain in the soil to a much greater extent, trees will grow. In Nebraska and Dakota millions of trees have been planted, and I saw last summer (1883) magnificent groves of trees, where ten years ago, nothing could be seen but a dreary waste.

There is a Menonnite settlement in Manitoba where, in seven years from the turning of the first sod, these settlers are enjoying the shade of large groves of trees which they had planted. Many similar instances of success are found in Iowa and Nebraska.

I give some extracts from a report made by ex-Governor R. W. Furness, of Nebraska, in December, 1882. It throws much light on what has been done, as well as what may yet be done in that State. The report was made by direction of the Commissioner of Agriculture for the United States. He says:—

"This paper is intended only as a brief presentation of experiences and results concerning the culture and tree-growing on the western plains, made by and coming under the immediate observation of the writer, during a residence of twenty-seven years west of the Missouri River, in the Territory and State of Nebraska, the principal object being to show what has been done practically, is being, and may be done, converting a naturally timberless portion of country into a tree-growing region. Taking the geography of boyhood's days, together with official reports of Captain Miles, U. S. A., and the western explorer, Colonel Fremont, relating to that portion of the national domain situated between the Missouri River and the Rocky Mountains, as a basis for conclusions, there was nothing at the date (1834) enticing to enterprising adventurers seeking new homes in the far west. The thought that the then naked plains would ever be transformed into groves of valuable timber was not entertained."

Governor Furness describes how the early pioneers discovered that when prairie fires were kept out there was a spontaneous indigenous growth of valuable varieties of timber. Still later, it was found that native seedlings transplanted into carefully prepared soil did well on high uplands out on the open prairie—not only did well, but grew with remarkable vigor and rapidity. To those of indigenous growth were added, in time, varieties of foreign origin. While success followed efforts in this direction, only the most sanguine experimenters had faith in ultimate practical results. In time the Territorial, and later the State Legislature, made liberal appropriations, and timber-growing in Nebraska is now universally conceded to be a success.

From 1854 up to and including 1882, covering a period of 28 years' reliable official statistics, it is found that there have been planted within the borders of what is now the State of Nebraska no less than 244,306 acres of forest trees. This includes seedlings, seeds and cuttings, planted in forests, groves and by highways. It is also estimated that since precautions have been taken against fire the spontaneous indigenous growth is equal to one-half of that area.

Personal observation would warrant a larger proportion. J. T. Allen, of Omaha, ex-secretary of the American Forestry Association, now an official of the Union Pacific Railway Company, a close observer, in a letter to Governor Furness, says:—"I have watched the spontaneous growth of young elms, oaks, walnuts, ash, hickories, &c., since fires have been kept back, and seen their growth among the hazel bush, which is the fringe in the border of native timber, dividing it from the prairie. I hardly think that I am out of the way in setting the spontaneous growth at double the amount of timber planted."

The fact noticed by Dr. Bell, of the Geological Survey branch, that trees are found growing on the sides of river banks facing to the north, and also on the northern slopes of hills, is noticeable everywhere on the plains, and is accounted for by the positions being less exposed to the sun's rays and the hot winds that come all the way from the Stano-Estacada, or Staked Plain. The winds that come from this Stano-Estacada have a parching and withering influence on all the vegetation of the plains—

is, in fact, almost as bad as the sirocco of the Lybian deserts, that desolates the fields of Malta, Sicily and northern Italy. It has been found that on the north side of plantations spontaneous natural growth is frequently the result, shelter from the sun and hot winds being a most essential factor in the early struggles for life in the young trees on the plains.

Governor Furness, in concluding his valuable paper, says:—"Thus far, few ills have attended timber culture in this State. The great losses, or failures, have been from careless handling, planting and after neglect. Where ground had been well and deeply prepared, good healthy plants used, care exercised in handling and planting, followed by attention and proper cultivation, until able to care for themselves, there has been no good cause of complaint.

"Too much importance cannot be attached to spontaneous timber growing. Nature, in this respect, is both accommodating and bounteous in her provisions. Waste places, as a rule, are utilized. Lands which, if at all adapted to other uses, could only be prepared at extra expense, are those nature occupies and renders of value. This growth comes of its own accord, so to speak, without preparation or labor by man, other than to guard against fires. A belief is freely expressed that greater proportionate successful tree-growing, and at comparatively no expense, has been done by nature than by planting. As stated before, by far the greater proportion of these stand and succeed than those of artificial processes. Losses are rare, and only from occasional invading fires, and where too thick on the ground the stronger kill out the weaker—no loss, in fact—simply adjusting or equalizing. Personal knowledge is had of many instances where lands, twenty years ago considered worthless, are now valued at from \$20 to \$100 per acre, solely for the timber naturally grown."

In Dakota experimental tree-planting has been attended with considerable success, and settlers are very sanguine of ample reward for their labors in that direction. The railroad companies are alive to the necessity of putting shelter belts along their roads, as well as providing for a future supply of cross-ties and sleepers for the repairs and extension of the tracks. The Northern Pacific Railroad Company, in 1882, expended over \$70,000 in tree-planting. They expect to be more than recouped in 12 years, for outlay and interest, by the thinning out of the plantations. They are still extending their work of tree-planting, and soon hope to have shelter belts that will secure them against drifts. In the winter of 1882-83 the loss by wear and tear of locomotives in bucking against snow drifts, together with the other contingent expenses connected therewith, entailed a loss to the company of over \$100,000. Their forester says that, in five years from the time of planting these shelter belts, the road will be secure against snowdrift obstructions.

The success attending these plantations gives strength and color to the belief that these plains were at one time covered with trees. Mr. F. P. Baker, in his report, already referred to, says: "The theory that the high plains were once covered with forests, and that at no remote period, is sustained by some remarkable facts. It is certain that the trunks of large trees are found in the bluffs and hills miles away from the water courses, and that not many years ago these giants of centuries' growth were quite numerous."

Professor F. B. Hough, in the first volume of his report, says: "It is evident that within a comparatively recent geological period timber grew on portions of Nebraska now entirely destitute of natural forests. Professor Anghey found, in 1868, in Cedar county, a log over 60 feet in length, and many others of various sizes. The charred roots of pine trees are often found sticking out of the ground, along the Nebraska River, on the northern border of the State, more than 50 miles distant from the nearest forest of to-day. The cause of the disappearance may fairly be ascribed to the destructive summer fires in exceptionally dry seasons, and this charred appearance of the roots helps to confirm this theory, which is further supported by obscure Indian traditions."

The late gallant General Custer, who had more than ordinary opportunities for acquiring knowledge on the point, and of observing the peculiar character of this remarkable country, in his interesting work, "My Life on the Plains," says: "Favoring the theory that the plains were at one time covered with forest, is the

fact that entire trunks of huge trees have been found in a state of petrification on elevated positions of the country, and far removed from water-courses."

One of the most interesting works that I find anywhere on the subject of the great prairies of the "Deserts of America," is by the Abbé Dominich, published by Longman & Co., of London, 1868. His pen-painting of this great and wonderful land is beautiful. Referring to the absence, or rather scarcity of trees, he says:—

"Wormwood and artemis plants are the predominating productions of the great plains, as likewise of all the other deserts; the origin of forests imagined by our novelists, are only to be met with in fertile grounds, and do not grow on arid soil. It is only towards the north that the prairies are dotted with forests, the existence of which has never been explained in a satisfactory manner, for they are sometimes exposed on heights where the wind would be apt to destroy them, and nevertheless they do not appear to suffer from its influence. To the north of the Nebraska these vast plains are less diversified, but more even, and are constantly refreshed by the breeze. Turf, bespangled with odoriferous and bright-colored flowers, adorns the dells and hills on which buffaloes and deer graze peacefully. It is evident that those regions were formerly wooded, for trunks of trees, and even entire trees, petrified, are often seen. Some *savants* attribute the disappearance of the ancient forests that heretofore covered the western prairies to the action of fire; others, to the change that the climate underwent, or to the natural sterility of the soil."

His description of the great overland trail, though not absolutely bearing on the subject of forestry, is, nevertheless, worthy of reading:

"In the great prairies, the undulations are formed by either hills of sand or of different kinds of soil or rock, which have often a most picturesque effect; they vary from 60 to 400 feet in height. The ground rises as it advances towards the west; for instance, the Kansas, at its junction with the Republican, is 930 feet above the Gulf of Mexico, and 150 miles more to the west it is 1,590 feet above the sea. The uniformity of these solitudes is only interrupted by a few hills or calcareous or sandy mountains, united in confused masses, cut up by ravines, and having the appearance of a fallen world. At other times they are intercepted by arid and rocky heights, which are almost impassable. In the middle of this ocean of verdure, whose enormous waves ever follow one another in their eternal mobility, winds, perhaps, the proudest road in the world, the one that the immigrants from Europe and the United States traced out, that they might the more easily go to enrich themselves at the gold mines of California. This immense avenue is like an area continually swept by the winds. The caravans that have passed and that still pass on this road are so numerous that the grass has no time to grow there. The savages, who had never seen any other thoroughfare but the hunting trails in the wilds, fancied, when they saw this road, that the entire nation of the whites had emigrated towards the setting sun, and that a vacuum was to exist in the countries where the sun rises. The graves of travellers succeed each other on the right and on the left of this great path of life and death, and the solitude around, like a funeral veil, overwhelms them with the image of repose and of the infinite. Numerous remnants of divers objects from exhausted caravans—entire families dying, cut down by disease, fatigue and misery—then the ground, whereon lie side by side and for evermore, whole populations of emigrants. Here and there funeral stakes are planted in the desert, bearing tokens of some great warriors or old sachems renowned for their wisdom. Extensive bone heaps indicate where entire droves of buffaloes were slaughtered by improvident Indian hunters. Rivers of all sizes roll their muddy waters over their beds of sand. Clumps of willows, or poplars, sparsely set on their banks, throw their melancholy shade over the silent waters. Roebucks and antelopes timidly brouse on the green sward of the prairie, with stretched-out ears, and ready to take flight at the least noise that may occur, for in these places a noise is always the signal of danger."

Reference has already been made to the baneful effects of the hot winds that frequently prevail on the plains; but it is only by experience that one can appreciate the intensity of their suffocating and parching heat, that exerts such a pernicious influence, not only on vegetable but also on animal life. I have seen men and animals remain for hours exposed to all the rigors of an afternoon's summer sun,

under the lee of a bluff, which afforded shelter from the sickening blast, although the delay entailed hunger and thirst, rather than encounter its blighting heat.

Bad as these siroccos are, they are harmless when compared with the terrible and destructive "blizzards" of the winter season. So destructive of life have these blizzards been, that people thoroughly conversant with western life assert that dreadful as have been the tomahawk and scalping knife of the Indian, the blizzards have caused greater loss of human life on those desolate plains.

The following description of one of these blizzards appeared in the Iowa Horticultural Report of 1872, from the pen of Mr. J. T. Mott:—

"I have oftentimes wondered how it could be that people were so easily lost in these storms—why it was that a man in good health, strong in limb and well clad, could not go a few rods from his house to the barn to care for his stock without danger of death; why whole sleigh loads of people were frozen to death within a hundred yards of dwellings, and this in the same location where I was living. But lately it has been my fortune (or, as I thought at the time, misfortune) to be caught in one of these storms in Minnesota; and it took only a short time for me to see through the whole thing. I first felt the wind blowing gently from the south; in less than thirty minutes it changed to a fierce gale from the west, bringing with it a bank of snow, compared to the rush of water as the flood gates are opened in a mill race, and with a force that no man or team could travel against it for a mile, as steady as a bellows run by machinery, being filled with snow as fine as the finest dust, and so thick one could not see 10 feet, filling the eyes and nostrils of man and beast. The storm lasted three days * * * and the news is of hundreds of dead people, frozen in stage coaches; whole sleigh loads frozen to death while returning home from town; men standing dead, with a hand on the stable door latch; others that saved themselves by burrowing in snow banks; little children lost going home from school; passengers in railroad cars two days without food, &c., &c.

"More people have been frozen to death within the last year in north-west Iowa and west Minnesota than are now murdered by Indians in these countries since their settlement. * * * The people are now petitioning their Legislature for some kind of protection from these storms, asking that fences and storm-houses be built along the travelled roads—asking them to do something for their safety. I see nothing that would do but tree-planting. It alone would do to stop these terrible winds, modify the climate, and furnish land marks to the traveller."

An American officer has told me of his experience in one of these blizzards. He was in command of a regiment of United States cavalry, and in pursuit of an Indian war party, and the scene was western Dakota. The command was going north, travelling slowly, waiting the return of scouts. Suddenly a black wall began to loom up in the west; its blackness and its vastness began to increase, as if in it all the teamsters and builders in creation were at work in shoving things. The command at once took in the situation. There was a high bluff, with perpendicular sides, some two miles ahead, and he instantly gave orders for an advance with all possible speed. It was a ride for life. They reached the shelter just as the storm struck them, and life was only preserved by continued exercises of men and horses during that terrible night. The waggons containing the tents and supplies were not so fortunate. Their teams, which were some distance in the rear, were overwhelmed in the fearful snow-drift; the mules could not travel fast enough to bring the teamsters into shelter before the snow enshrouded them. The poor mules perished in the terrific cold; the men in charge with difficulty saved themselves by huddling together under the buffalo skins which the waggons contained.

Many other harrowing accounts could be given of suffering and death caused by these fearful winter storms; but enough has been given to show the great necessity of shelter-belts and other forests, to make this fertile land desirable as a home. That something should be done, and done quickly, there can be no particle of doubt—not for the protection of human life alone—the trees would afford shelter for cattle and other domestic animals, and it is a well-known fact that pasture continues fresh and green much longer in the shade of trees than when exposed to the full glare of the sun.

In connection with the subject of prairie tree-planting, Mr. Stewart Thayne, whom we have already quoted, says:—

"In the various accounts I have had of the prairie lands of the North-West, I find frequent mention made of the sudden changes of temperature. Severe frosts occur sometimes after the crops have been reaped; or the temperature of the night is much lower than that of the day. Then these plains are exposed to violent tempests through the cold currents of Arctic regions coming into contact with the heated ones of the plains. To ameliorate a climate presenting such contrasts, there is only one method, that of tree-planting, wherever the nature of the soil will permit, and forming the settlements under the shelter of these plantations. Of so great importance is this to our western country that, in my opinion, upon its solution depends whether that region will realise the sanguine expectations now entertained of its being able to support an immense population; or whether, after many sore disappointments, perhaps, it will deserve the name of the 'Lone Land.'"

The work to be done is one of great magnitude. The Government, the railroad companies, the land companies, and the people, have all to do their share. But the initiative must be taken by the Government; and I am satisfied that the first and most essential step that could be taken in promotion of this great work would be the establishment of forestry experimental stations at several points in Manitoba and the North-West. The great importance of such stations cannot be over-estimated; their absence was long felt in Europe, and in 1868, at a congress of foresters held at Vienna, in which the principal German States were represented by forest officers of distinction, a committee was appointed who drew up a report which was adopted, and the establishment of forest experimental stations throughout Germany was the result.

In an able and interesting paper, read by Adolphe Lowe, secretary of the Ohio Forestry Association, at Cincinnati, last April, entitled, "Our Next Problem," he thus alludes to these German forestal experimental stations:—

"The great aim of these stations is to furnish a scientific as well as practical foundation for a rational management of forests, based upon exact experiments and careful investigation. They are intended to determine the significance of forests in the economy of nature, and to try the various methods of forest management, and to examine the advantages which one method may have over another, and finally to establish a plan of forest administration which will enable us to realise the greatest profits, and at the same time reduce the expense of their administration."

To us who are, as it were, in the A B C of forestry education, the experimental stations would be a great benefit, and I think steps should be immediately taken towards their establishment. They would enable us to solve many of the problems that otherwise might lead to pitfalls and failures. Extensive tree-planting on the plains present many, and perhaps insuperable difficulties, and the experience to be had at these stations would show us how to avoid failures and guide us on the road to success. In them we could find out not only what trees could be grown, and their adaptability to the soil, but we could also determine the value of forest litter on the growth of trees. In them, also, a study could be made of the animal and vegetable foes of trees, and perhaps the best means devised to counteract them. There, also, could be learned the best method of planting and thinning, and reliable tables of increase could be acquired, as well as the most practical methods of valuing forests.

There would be also failures to notice, and thereafter to avoid, for knowledge thus gained is a direct advantage, by preventing future disappointment and loss.

These stations should be of considerable size, so that there might be opportunity of testing the merits and diversity of depth and character of soil and sub-soil; and to be of easy access in the way of location, in regions not far distant from leading lines of railroads. They could be utilized as nurseries for raising young trees to supply the settlers, as well as for future use in forest plantations. They could also be made stations for meteorological observations, thus affording further opportunity of continuing scientific experiments for the public good.

After the positions of the stations had been determined on, the first work to be done on a forest reserve would be the providing of suitable buildings for the superintendent and his staff, during the building of which land for the planting of wind-breaks or shelter belts could be prepared. For this purpose the most convenient of

the indigenous young trees to be found might be utilized. There would be little or no difficulty in finding on the sand bars or banks of many of the streams and rivers sufficient young cottonwood and willow trees for this purpose.

The experience already gained by those who have had opportunities of testing the merits of the different native trees and shrubs would lead us to adopt, in the first instance, for the purpose stated, the two kinds above named, and the box elder or ash-leaved maple. They are hardy, tough, and seem to be best adapted to resist the force of the winds which blow over these plains with great violence, and are as constant as the trade winds that blow over the ocean in low latitudes.

Within these shelter belts there should be room for extensive experimental investigation of forestry in all its bearings, and it might even be deemed advisable to connect them with experiments in horticulture and agriculture.

A first position and absolute necessity would be a thorough preparation of the soil. Without this, failure is sure to follow. The sod on the prairies is peculiarly tough, and can only be made subservient by judgment, labor and patience. The time for the first ploughing is when the vegetation is most vigorous, and before the ground becomes hardened with drought, as it often does in the latter part of summer. Of course, the seasons vary much in the quantity of rain that falls, and the facilities for ploughing would be much influenced by circumstances. From observation, experience and information carefully gleaned, I would advise the growing of a grain crop the first year after preparing the soil. This would leave the soil in much better condition, and the young plants would be less liable to be choked by weeds.

It would be well, when possible, to select tracts of land that contained soil of various characters—clayey, loamy and sandy. Within these shelter belts, by careful observation, the influence of the trees in the different soils might be more accurately determined. In fact, here would be a field for careful observation and experiment, offering an opportunity of discovering and making known to the country such results as might be found important to the settlers.

A considerable amount of manual labor would be required on these stations, and an opportunity would here offer for the employment of young men who might wish to acquire practical knowledge of tree-planting and forestry, who, under competent direction, might fit themselves for its higher grades.

As several such stations would be necessary in order to be of more general use to all in our vast territory, and as the range of climate—which is influenced as much by altitude as latitude—would necessitate a variety in the experiments to be made, the student might be allowed to spend a portion of his time in each, thus affording him an opportunity of acquiring a larger and more extended field of information.

Speaking of these forestal experimental stations, Professor Lowe, whom we have already quoted, says: "A very successful beginning has already been made in Germany, where the idea of forestal experimental stations originated. One or more chief, with an appropriate number of secondary stations, have been founded in nearly every State of Germany. The great importance which the Governments of the respective States attach to these stations may be seen from the fact that in Germany about \$80,000 are expended annually for the maintenance of these stations, and from the other, that the number of these stations is steadily increasing. Austria, Switzerland, Italy, Spain, and even Russia, are following the example of Germany.

"If these countries, in which the attainments of forestry are truly great, deem it advisable and necessary to submit the maxims of long experience to a series of scientific investigations and systematic experiments, how much should we, on this side of the Atlantic, who are profoundly ignorant of almost everything pertaining to forestry, make an effort to base that system which is to be our guide in the raising and management of forests upon scientific principles?

"The great need of forestal experiment stations in the United States and the Dominion and Provinces of Canada has long been felt, and the desire for the establishment of the same has been expressed in various ways and at different times, but to no effect, because of the want of a suitable plan of organization. Our climate, the nature of our forest trees, the want of State forests and of trained foresters, render the adoption of the German plan inexpedient, and demand a plan adapted to our

peculiar circumstances, and which would, at the same time, fulfil the demands which can reasonably be made on such an institution.

"Such a plan was laid before the American Forestry Congress by a representation of the Ohio State Forestry Association, at St. Paul, Minn. The Forestry Congress not only heartily endorsed this plan, but, upon a resolution, appointed a committee to recommend the adoption of the same by the several States of the Union, and several Provinces of Canada."

Much valuable experience has been gained in Minnesota, Iowa, Nebraska and Dakota. The conditions of soil, the climate and physical aspect of these States and Territories resemble, in a remarkable degree, our great North-West, with slight advantages peculiar to some of these places not enjoyed by others. Iowa and Nebraska, lying some distance south of us, have the advantage of spring a little earlier, and summer lingers there a little longer; but the extremes of heat and cold, sunshine and shower, prairie plain and bluff, are very much alike. Our soil is richer, our summer days are longer, and we seem to be free from the cyclones and tornadoes so frequent in the States adjoining us.

It is, however, much to the credit and enterprise of these States that they not only experimented on the possibility of tree-planting with native trees and shrubs, but have for years been importing forest and fruit trees from northern Europe. Last year Professor J. L. Budd, of Iowa State University Horticultural Chair, was sent to Europe; and in Russia he found, in latitudes and climates similar to the great American North-West, a state of horticulture and arboriculture that is very remarkable, and calculated to inspire us with the hope of seeing our new acquisition, once the "Great Lone Land," transformed not only into wheat fields, but into a land of groves, woods and orchards.

We know that all countries situated on the west coast of Europe have their climate much tempered and modified by the breezes of the Atlantic Ocean, even as far north as the Faroe Isles. But the eastern European plain resembles, in a remarkable degree, the great plains of the North American continent. Professor Budd, speaking of it, says: "This counterpart of our western prairies and plains covers, like a blanket, the larger part of continental Europe on the north-west, passing, without any elevations to speak of, into the plains of northern Asia. The borders of this plain are only washed at the north by the waters of the frozen ocean, and in the west and south by the inland Baltic, Gulf of Finland, the Caspian and the Black Seas. With the Caucasus and Carpathian Mountains to the south, the prevailing winds prevent the moisture of the Caspian and Black Seas from benefiting the air of even the prairies nearly adjoining them; while the dry winds of the deserts and sterile steppes of the south-east shrivel the foliage of the trees and plants of central Russia, as do our south-west winds from the dry plains of New Mexico."

The valley of the Volga has a very rich soil, a silt deposit, like that of the valley of the Red River of the North-West. At Saratov, on the Volga, in latitude 52° (same as Winnipeg) the rainfall is less and the climate more arid, while the temperature is about the same as in similar parallels in Manitoba, and Mr. Budd adds that, from his observation, "the summers and winters of central Russia approach ours very closely."

Mr. Budd also adds that the sudden changes of temperature and air, so far as he could judge from one summer's experience, favored the idea that the changes of wind brought atmospheric changes as sudden and complete as on the western prairies. As to winter changes, he was told at Jula of a winter, twelve years ago, when a warm south-east wind, taking off all the snow, was followed by a north-eastern gale running the thermometer down to 45 degrees below zero. Mr. Budd further adds:—

"The observations of Russia and Canada record the temperature of the sheltered cities rather than that of the open country. Educated members of the forestry staff of Russia, and intelligent nobles and proprietors, often gave records of extreme winters far lower than what we have given."

Mr. Budd's chief aim in visiting Russia was to ascertain what could be obtained in hardy fruit and other trees, that might be more desirable than that found at home. In the Province of Kazan, about 430 miles east of Moscow, the south part of the Province being in the 58th parallel of north latitude, a far inferior climate in

extremes of summer and winter conditions, he found apple-growing a chief industry of the peasants and some of the large landowners. At a forestry convention at Moscow he became acquainted with the conservator of forests of this Province, and he kindly accompanied Mr. Budd and his friend, Mr. Charles Gibb, of Abbotsford, Quebec, to examine the orchards of Kazan. Mr. Budd's report says: "With his constant and zealous aid as guide and interpreter, we were able to study the orchards of the most trying fruit-growing regions of the world very thoroughly. The largest and best orchards on the bluffs, on the west bank of the Volga, or on the dry prairies just back of these bluffs. We found the dwarf-appearing trees loaded with high colored and really good fruit, and we could scarce see a trace of injury by the terrible winters of these latitudes. Our intelligent guide assured us that five years before, on these exposed bluffs, the mercury went down to 48 degrees, Reaumer, or 58 degrees below zero, Fahrenheit. The winter before our visit the lowest point reached was 40 degrees below. These low temperatures do not seem verified by the records in the sheltered city of Kazan, on the east bank of the Volga; but this is the experience in Europe in comparing the records of the great cities with those of the exposed plains."

At Saratov there is a very large trade done in fruits, and Mr. Budd visited one orchard that had 12,000 apple trees. It was one of many in the vicinity. The proprietor, two years previously, sold over 20,000 barrels of apples. The latitude of this orchard was 700 miles north of that of Mr. Budd's home at Ames, in Iowa.

It was a cause of great gratification to see such vegetation in these high latitudes, and filled the visitors with much hope for the future of our great prairies.

The success achieved on these Russian steppes affords us subject for much thought, as well as hope for our own future in a similar direction. Many of these plantations are fully 200 years old, and resemble islands on a vast ocean; the main object in planting them was a modification of the climate. As already stated, the small Province of Julia has seven of them, with an aggregate of about 140,000 acres.

At Proskan is one of the best schools of horticulture and forestry to be found in Europe. It lies north of the 50th parallel, and of the Carpathian Range, and is in the zone of the east plain, and not blessed with a rich soil. The school has an experimental arborium of the hardiest horticultural products of the north plain, and many of the most desirable trees and shrubs of the east plain. The enclosure contains 300 acres, and in it may be found one of the best fields for study (for our purpose) to be found in the world. It is believed that the lessons to be acquired on these great Russian steppes would be of infinite value to us on the great steppes of our North-West, which they resemble in soil, climate and physical aspect to a remarkable degree.

It has been already shown that the denuding of the country of its trees caused an abnormal condition of the rivers and streams. They, in this abnormal state, are subject to sudden rises and falls, and here the question suggests itself: Why are the rivers of our prairie country in an abnormal state? Would not the reforestation of a fair proportion of the plains cause a change in the level of the waters of the Red River, Saskatchewan, Assiniboine and other rivers, that are now subject to such extremes of high and low water? These streams are remarkable for the very great difference there is between the high and low stages of the water, and it may reasonably be presumed that, if their banks, and the hills that shed the rainfall so suddenly, were clothed with trees, whose foliage would protect the earth from the burning rays of the sun and the parching heat of the sirocco, that the mosses and the porous earth would hold and store the water until it found its way gradually to the river, preventing floods and causing a more regular water level, thus prolonging the season of navigation, and giving the people greater facilities for marketing the fruits of their labors, and contributing largely to the prosperity of the country. There were formerly on these plains streams and lakes that exist no longer, and there is good reason to believe that, with the restoration of the forests, many of these would have their waters again sparkling in the sunshine. That wood and water formerly existed in many places where now there is neither, is shown by the appearance of dried-up beaver dams remote from stream or lake. The work of disiccation is still advancing. The Canadian Geological Report, 1873-74, page 27, says, "The lakes and

lake basins are abundant. They appear to be gradually diminishing in size, and drying up." This, he was informed, had been going on steadily for many years, and that what had been large lakes were now pools, and all the lesser ones are already quite dry.

In Utah, the great Salt Lake, under the influence of the groves, orchards and other plantations set out by Mormons, which now throw a grateful shade on the surrounding hills, has increased in magnitude, and it is said that many of the minor lakes and some of the rivers have increased their volume of water, while streams are not nearly so subject to extremes of level of high and low.

In an eloquent and interesting address delivered by Mr. Emile Roth, at Cincinnati, before the American Forestry Congress, in April, 1882, the influence of the absence of trees on rivers of the prairies was pointedly and clearly referred to. Speaking of the Upper Mississippi, he said :—

"Thirty years ago steamboats drawing 6 feet of water made regular trips on this river, up as far as St. Paul. Now, the navigation with boats of half that draught is uncertain enough. Nearly all the tributaries of the Upper Mississippi have lost one-half, or even more, of their former supply of water. Inundations in the spring are now frequent, while in the summer time the depth of some of those rivers averages hardly more inches than it could have been measured by feet thirty years ago. Water powers which were formerly deemed to be inexhaustible have been entirely abandoned, or their failing power has been replaced by steam. In the remembrance of the older settlers, the climate of Wisconsin and Minnesota was remarkably steady, the winters were long and cold, the supply of snow ample and regular, and late frosts in the spring were unusual. Now, the inhabitants complain of abrupt changes of temperature in all seasons of the year, and of the irregularity of the snow-fall. The Legislature of Wisconsin has already paid attention to these alarming facts, and has taken the preservation of existing forests and the establishment of artificial ones into earnest consideration. By a resolution recently passed, it asks of the National Government the transfer, for that purpose, of all unsold public lands in the State, which are now despoiled of their lumber by thievish lumbermen."

Mr. Roth refers to many instances of the injurious results of denuding the country of its trees. He says, speaking of Arizona: "The hills and slopes were once stocked with timber, which was wasted by the inhabitants, whereafter the same deterioration of the country gradually took place which we notice in Palestine, Greece and Sicily; and, finally, the people had to migrate, to avoid starvation."

NECESSITY FOR IMMEDIATE ACTION.

But enough of the warning examples of history.

It is not too late for repairing much of the damage that has been done by the destruction of our forests. A regulation for the use of the timber may be effected without any injury to the legitimate lumber trade, and the re-planting as well as the establishment of artificial forests may undoubtedly be made profitable for private as well as for public enterprise. If it is found remunerative to acclimatize American trees in Germany and France, where land is much higher in price than here, why should it not be remunerative to cultivate them in those parts of America in which lumber is scarce and precious? They grow quicker here, and to greater perfection than elsewhere. Nature has lavishly provided this country with an uncommonly large number of the valued species of trees. There are not more than thirty-five species and distinct varieties of trees in France that attain to a height of 30 feet; not more than sixty-five in Germany; but over one hundred and fifty in the upper part of the Mississippi valley alone. The renowned botanist and explorer, Sir J. D. Hooker, was much surprised and charmed with the remarkable extent of the variety as well as the great size of the trees in the valley of the Upper Mississippi, and could he again revisit this beautiful country he would be disgusted to see how the people, in their greed and selfishness, had destroyed what a benign Providence had so lavishly bestowed.

It is much to be regretted that the forests of Manitoba and the North-West are being slashed and wasted with a recklessness similar to that which characterized the destruction of the woods of the old Provinces.

These woodlands, in view of the large population the prairies are capable of supporting, should have been kept as permanent reserves, to supply the wants of the settlers, permitting only the mature trees to be cut down. It is painful now to see millions of fine young trees being cut down, and their branches left to litter the ground, acting as trains to conduct the prairie fires to destroy those that are still too young for the axe. It is only under a more provident system, when our forests will be cared for with due regard to the future, as well as our present wants, that such waste as is now going on can be checked.

All our present forest land should be carefully surveyed, laid out in districts and chartered, and the character and profile of the land described. Timber experts, or competent wood-rangers, should be sent to examine, appraise and report on their value and availability; and then the mature timber *only* should be sold.

CONCLUSION.

In this preliminary report there is neither time nor space to go much into detail. The disasters which the destruction of the forests have caused in ancient, mediæval and modern times have been referred to, and the probable evils that might befall our country under like circumstances, have been pointed out. The measures which have been and are being taken by all progressive civilized nations to remedy the evils caused by former waste and to provide for future supplies have been shown. The improved systems of forestal education in the leading schools of Europe have been brought under review; and the results achieved by those States and countries whose climate and geographical condition most closely resembles ours have been examined. Enough has been shown to make it evident that it is the duty of our Government to adopt measures, immediately, to arrest further destruction of our remaining forests (except under some very improved system of supervision), and to replant, where practicable, the high lands which were formerly covered with forest trees, and also to devise or adopt some plan or system of forest plantations for the great stepped region of the North-West. American trees have been acclimatized in Europe, and it is found to be a lucrative enterprise to grow them. It is quite probable that we may find some species of trees in northern Europe that would be better adapted to our prairie country than any that we have. Of the great necessity of trees on plains there is no doubt. Of the probable success of growing trees there, I believe there is none. The late Leonard B. Hodges, Chief Forester of the Northern Pacific Railway, says, in speaking of the vicissitudes of climate to which Minnesota, Dakota, Manitoba, and the North-West Territories are exposed:—

"Forestry is the prime factor, the central figure, in the whole business. I have neither time nor patience to even attempt to answer the puerile arguments and the unfounded assertions that trees won't grow on the western prairies. Life is too short to fool any portion of it away in that direction. Facts, not theories, claim our attention. The fact that, within the last ten years, hundreds of groves, containing millions of healthy, vigorous young trees, are now growing far out in the treeless region where science had preordained and doomed the work an impossibility, must be acknowledged. The fact that young groves of forest trees are now being grown on the line of the Northern Pacific Railway, away out and beyond the 150th Meridian, has also got to be admitted, science and its votaries to the contrary notwithstanding."

The United States Government and Governments of many of the individual States did much in the way of legislation to induce farmers to go into tree-growing as a business, as well as an aid towards home comfort and adornment, but their efforts have not been crowned with success. Many of the statutes passed, after revisions and modifications, were repealed. In 1873-74 an Act called the Tree Culture Act was passed by the United States Congress. Its provisions were evaded by the land grabbers, and it was found not to work well. It was amended in 1876, and again in 1877, but notwithstanding the carefulness of the provisions, it was found open to abuse. Unscrupulous speculators managed, under false pretenses, to lay claim to the most desirable locations, and held them, without making the necessary improvements. They, however, often succeeded in making large sums of money by selling to actual settlers, who wished to obtain the lots as homes.

Last year the United States Government sent a commissioner to report on the working of the law, and his investigation led him to report in favor of its total repeal, as it had utterly failed to accomplish the object for which it was introduced.

The States of Iowa, Kansas and Nebraska had each passed laws giving premiums for tree-planting on the prairies, but, after a few years' experience, they were repealed, or very materially modified. It was found that what was intended to encourage tree-planting had, in most cases, led to fraudulent claims for premiums.

In any system that may be adopted by Canada, special care should be given to see that provision is made for the fullest enforcement of the laws. By this means only can we expect to see our remaining forests protected from utter destruction, or new ones produced, and our prairie country beautified with groves and plantations, and thus made attractive to the millions of people who are likely to make their homes on these fertile plains.

Almost all the civilized nations of the world long ago realized the danger that their improvidence and carelessness had caused, and have taken the most thorough and systematic steps towards the protection and reproduction of their forests, and in this have shown a striking contrast to the wastefulness and neglect that have characterized the conduct of those who have control of the great forests of America. The noble work of reforestation in France, an account of which is given by the Rev. J. Crombie B. . . . well worthy of our admiration and emulation. There we can learn how many of our torrents have been chained, extensive valleys have been rescued from destruction, restored to fertility and secured against future inundations; millions of acres of barren wastes and dunes of drifting sand have been converted into luxuriant and fertile forest domains; and how large districts that had been abandoned as uninhabitable were transformed, by the restoration of forests, so as to become desirable as the homes of large agricultural communities.

In Russia, much of the land on the bleak and inhospitable steppes has, by the planting of forests, been reclaimed and made capable of supporting, in comfort, a numerous and industrious peasantry.

If we would keep up with the march of progress and civilization of our time, if we would do our duty to the noble heritage with which God has endowed us, we must no longer defer a work which is of such paramount importance, and so absolutely essential to our prosperity as a people. The examples set us by France, Germany and Russia are not to be overlooked.

The Government of the Dominion should, without loss of time, appoint a Forest Commission, to co-operate with a similar Commission from every Province in the Dominion, to deal with this all-important question of the protection of our old forests and the production of new forests.

In closing this preliminary report, I can think of no more appropriate words than a quotation from a very able lecture on the subject of forest preservation, delivered by Professor E. K. Price, before the American Philosophical Society, of Philadelphia, in 1877. After elaborately picturing the desolation that overspread those countries that have been denuded of their trees, he finished his discourse in the following words:

"The facts are abundant that to part with the trees is to lose the springs they protected, the running streams the springs supply, and the volume of the broad river. These lost, all the charm of the landscape has fled, and this source of man's refinement and civilization has left the world. With the loss of rains and springs, the fruitfulness of the world passes away. Grass fails for flock and herd, and the bread of life is no longer sure for man, and only because man has betrayed his trust."

J. H. M.

APPENDIX.

ENACTMENTS TO ENCOURAGE TREE PLANTING AND THE PROTECTION OF FORESTS.

U. S. TIMBER CULTURE ACT OF 1878.

An Act to Amend an Act to Amend an Act intituled: "An Act to Encourage the Growth of Timber in the Western Prairies."

[Approved June, 1878.]

Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled, that the Act intituled: "An Act to Amend an Act to Amend an Act to Encourage the Growth of Timber on the Western Prairies," approved March 13th, 1874, be, and the same is hereby amended, so as to read as follows:—

Section 1. That any person who is the head of a family, or who has arrived at the age of 21 years, and is a citizen of the United States, or who shall have filed his declaration of his intention to become such, as required by the naturalization laws of the United States to become such, who shall plant, protect, and keep in a healthy condition, for eight years, ten acres of timber on any quarter-section of any of the public lands of the United States, or five acres on any legal sub-division of eighty acres, or two and one-half acres on any legal sub-division of forty acres, or less, shall be entitled to a patent for the whole of such quarter-section, or of such legal sub-division of eighty or forty, or fractional sub-division of less than forty acres, or as the case may be, at the expiration of said eight years, on making proof of such fact by not less than two credible witnesses, and a full compliance of the further conditions provided in section two: Provided further, that not more than one-quarter section of any section shall be thus granted, and that no person shall make more than one entry under the provisions of this Act.

Section 2. That the person applying for the benefits of this Act shall, upon application to the Registrar of the land district in which he or she is about to make such entry, make affidavit, before the Registrar, or the Receiver, or the Clerk of some Court of Record, or officer authorized to administer oaths in the district where the land is situated, which affidavit shall be as follows, to wit:—I, ———, having filed my application, number ———, for an entry under the provisions of an Act, entitled an Act, &c., &c. (as above), I do solemnly swear that I am the head of a family (or over 21 years of age) and a citizen of the United States (or have declared my intentions to become such); that the section of land specified in my said application is composed exclusively of prairie lands, or other lands devoid of timber; that this filing and entry is made for the cultivation of timber, and for my own exclusive use and benefit; that I have made the said application in good faith, and not for the purpose of speculation, or directly or indirectly for the use or benefit of any other person or persons whomsoever; that I intend to hold and cultivate the land, and to fully comply with the provisions of this Act; and that I have not heretofore made an entry under this Act, or the Acts of which this is amending. And upon filing said affidavit with said Registrar and said Receiver, and on payment of ten dollars, if the said tract applied for is more than eighty acres, and five dollars if it is eighty acres or less, he or she may thereupon be permitted to enter the quantity of land specified; and the party making an entry of a quarter-section under the provisions of this Act shall be required to break or plough five acres covered, or thereby, the first year; five acres the second year, and to cultivate, to crop, or otherwise, the five acres broken or ploughed the first year; the third year he or she shall cultivate, to crop or otherwise, the five acres broken the second year, and to plant in timber seeds or cuttings the five

acres first broken or ploughed, or to cultivate and put in crop or otherwise the remaining five acres; and the fourth year to plant in timber seeds or cuttings the remaining five acres. All entries of less quantity than one quarter-section shall be ploughed, planted, cultivated to trees, tree-seeds or cuttings, in the same manner and in the same proportion as hereinbefore provided for a quarter-section. Provided, however, that in case such trees, seeds or cuttings shall be destroyed by grasshoppers or by extreme and unusual drought for any year or time of year, the time for planting such trees, seeds or cuttings shall be extended one year for every such year they are so destroyed. Provided further, that the person making such entry, before he or she shall be entitled to such extension of time, file with the Registrar and the Receiver of the proper land office an affidavit, corroborated by two witnesses, setting forth the destruction of such trees, and that in consequence of such destruction he or she is compelled to ask for an extension of time, in accordance with the permission of this Act. And provided further, that no final certificate shall be given or patent issued for the land so entered until the expiration of eight years from the date of such entry; and if at the expiration of such time, or at any time within five years thereafter, the person making such entry, or, if he or she be dead, his or her lawful representatives, shall prove by two credible witnesses that he or she or they have planted and, for not less than eight years, have cultivated and protected such quantity and character of trees as aforesaid, that not less than twenty-seven hundred trees were planted on each acre, and that at the time of making such proof there shall be then growing at least six hundred and seventy-five living and thriving trees to each acre, they shall receive a patent for such tract of land.

Section 3. That if at any time after the filing of this affidavit, and prior to the issuing of the patent for said land, the claimant shall fail to comply with any of the requirements of this Act, then, and in that event, such land shall be subject to entry under the homestead laws, or by some other person, under the provisions of this Act: Provided that the party making claim to said land, either as a homestead settler or under this Act, shall give notice to the original claimant, as shall be prescribed by the rules established by the commission of the general land office; and the rights of the parties shall be determined as in other contested cases.

Section 4. That no land acquired under the provisions of this Act shall, in any event, become liable to the satisfaction of any debts contracted prior to the issuing of the final certificate therefor.

Section 5. That the Commissioner of the General Land Office is hereby required to prepare and issue such rules and regulations, consistent with this Act, as shall be necessary and proper to carry its provisions into effect, and that the Registrars and Receivers of the several land offices shall each be entitled to receive two dollars at the time of entry, and the like sum when the claim is finally established and the final certificate issued.

Section 6. That the fifth section of an Act intitled: "An Act in addition to an Act to Punish Crimes against the United States and for other purposes," approved 3rd March, 1857, shall extend to all oaths, affirmations and affidavits required or authorized by this Act.

Section 7. That parties who have already made entries under the Act approved 13th March, 1874, shall be permitted to complete the same under the provisions of this Act.

Section 8. All Acts and parts of Acts in conflict with this Act are hereby repealed.

ENCOURAGEMENT OF TREE-PLANTING.

In 1874 the State Legislature of Illinois passed an Act empowering the Boards of Supervisors of Counties to offer a premium of \$10 per annum, for three years, for each acre of land planted in trees, the trees not to be more than 10 feet apart.

In 1868 Iowa passed an Act for the encouragement of tree culture. It enacted: "That there shall be exempt from taxation (of) the real and personal property of each tax-payer who shall, within the State of Iowa, plant and suitably cultivate one or more acres of forest trees for timber, the sum of \$100 for ten years, for each acre

so planted and cultivated: Provided, that the trees on the said land shall be kept in a healthy and growing condition."

In 1872 this Act was amended so as to extend the premium to tree-planting on highways.

Kansas, in 1868, passed an Act which gave \$2 per acre for the planting and proper care of each acre so planted, for ten years. A like bounty was also offered for each half-mile of trees, not more than one rod apart, planted along any public highway.

Maine, in 1872, enacted a law by which each acre of land, properly planted and cultivated, would be exempt from taxes for twenty years.

Minnesota, in 1873, passed an Act which gave premiums similar to those given by Kansas.

Wisconsin, by law passed in 1868, enacts that every possessor of five or more acres of land, who shall reserve one-fifth thereof, either from natural growth, or successfully grown by planting, shall be exempt from taxation until the trees shall reach a height of 12 feet. Whenever the trees shall have attained a height of 12 feet he shall be entitled to \$2 per acre for each acre so planted or grown as a tree-belt, which bounty shall be allowed as hereinafter provided; and the certificate shall be received by the collector of taxes assessed on the entire, of which the tree-belt forms a part, as so much cash.

Tree-belts so planted shall be on the west or south side of each tract of land, and shall not be less than 30 feet wide, but no belt shall exceed more than one-fifth of the entire tract of land on which the same is planted; provided, that, if the east and north sides of any tracts of land, or either of them, be bounded by a public highway or street, then a tree belt one rod wide, may be planted next to said highway or street, and the same shall be entitled to all the benefits of this Act, although such last-mentioned tree-belt shall, with the last-mentioned tree-belts on the west and south sides, exceed one-fifth part of the whole of the said tract of land.

The tree belts to be entitled to the benefits of this Act, for each five acres of land, must be 30 feet; for each ten acres of land, 60 feet wide, and for 40 acres 100 feet wide, and must be on two sides of each square tract of land, and all tree-belts owned by the same landowner must be planted not to exceed one quarter of a mile apart, or on the west and south sides of every 40 square acres of land; and the tree-belts may be divided and planted on any other lines within 40 square acres, by permission of the assessor.

It is also provided for in this Act that if by neglect, pasturing, or thinning out, or otherwise, the owner shall lose the benefits of this Act, until it shall be again accepted and certified to by the assessor, whose duty it is to make a personal examination annually of the condition of these plantations. Should the assessor deem them neglected, as above, the land shall be assessed like the remainder.

Almost all the States and Territories have laws for the protection of shade trees, and for promoting the culture of trees in public highways.

In 1883 the Province of Ontario passed an Act to encourage the growth of shade trees on highways, and there was also a provision about growing trees on boundaries between adjoining farms, but the law does not seem to be popular, as I am not aware of its having been adopted by any municipality. It would hardly be advisable, with our moist atmosphere and clayey soil, to plant shade trees on our country roads. Moreover, there is a section in the Ontario Municipal Act (524) which authorizes municipal councils to cut down trees on private property when they cause the roads to keep muddy by too much shade.

Shrubs or fruit trees would conduce much to beautify our roads, and would not shut them out from the sunlight, so necessary to dry them after heavy rains.

LAWS FOR PROTECTION AGAINST FIRES.

In the statutes of Dakota it is provided, by an Act passed in 1869, to prevent the firing of woods, marshes and prairies:—

Section 1. If any person or persons shall wilfully set on fire, or cause to be set on fire, any woods, marshes or prairies, with intention to damage or injure the pro-

party of another person, such person or persons so offending shall, upon conviction thereof, be fined in a sum of not more than \$500 or less than \$50, and imprisoned in the county gaol not more than 6 months nor less than 30 days, or both, at the discretion of the court, and shall be liable for all damages done by such fire.

Section 2. If any person or persons shall negligently or carelessly set on fire, or cause to be set on fire, any woods, marshes or prairies, the person or persons so offending shall be fined in a sum of not more than \$100, nor less than \$10, upon conviction thereof, and shall be liable to the injured parties for any damage occasioned by any fire set or caused, as aforesaid, to be recovered by civil actions.

Section 3. That any person or persons setting on fire, or causing to be set on fire, any woods, marshes, prairies or lands owned or occupied by him, or her, or themselves, for the purpose of securing his, her or their own property from damage or destruction by prairie fire, shall be held liable for all damage occasioned thereby: Provided, that nothing in this Act shall be so construed as to prevent any person or persons from firing against fire when his, her or their own property is in imminent danger of damage by the near approach of prairie fires.

Section 4. It shall be lawful for any person or persons to set on fire, or cause to be set on fire, any marshes or prairies owned or occupied by him, her or themselves, during the months of March, April and May: Provided, that the person or persons desiring to set such fire shall give at least twenty-four hours' notice to all persons occupying lands within one mile of the place where such fire is to be set.

Section 5. No property, real or personal, shall be exempt from seizure and sales on execution issued to satisfy any judgment obtained under the provisions of this Act.

Section 6. All Acts and parts of Acts in conflict with the provisions of this Act are hereby repealed.

Illinois has laws more exacting in their provisions than those of Dakota. The third section holds servants, unable to pay fine, liable to be publicly whipped, to the extent of 39 lashes. There is also an Act relating to fires caused by locomotives. It reads:—

Section 1. That in an action against any person or incorporated company for the recovery of damages on account of any injury to any property, whether real or personal, occasioned by fire communicated by any locomotive engine while upon or passing along any railroad in the State, the fact that such fire was so communicated shall be taken as full *prima facie* evidence to charge with negligence the corporation or person or persons who shall, at the time of such injury by fire, be in use and occupation of such railroad, either as owners, lessees, or mortgagees, and also those who shall at such time have the care and management of such engine, and it shall not, in any case, be considered as negligence on the part of the owner or occupant of the property injured that he had used the same in the manner, or permitted the same to be used or remain in the condition it had been used or remained, had no railroad passed through or near the property so injured, except in cases of injury to personal property, which shall be at the time upon the property occupied by such railroad. This Act shall not apply to injuries already committed.

The laws of Indiana, in regard to setting fires to woods, prairies or marshes, much resembles those of Illinois.

In Iowa, an Act passed in 1862, and which has since been incorporated in the code, provides: "That if any person set fire to, or burn, or cause to be burned, any prairie or timber land, allowing such fire to escape from his control, between the first day in September, in any year, and the first day of May following, he shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be imprisoned in the county gaol not more than thirty days, or punished by fine, not exceeding one hundred dollars."

This Act was modified in 1878, so as to hold any person who wilfully sets fire to any field, prairie or timber, to be liable to a fine of \$500, or to be imprisoned in the county gaol for not more than one year.

Michigan has suffered more from fires than any State in the Union. In 1846 it was enacted that if any person should wilfully or negligently set fire to, or cause to be fired, any woods, prairie or other grounds not his own property, or should wilfully or negligently permit fire, kindled by himself or by his order or permission,

to pass from his own lands to the injury of other persons, he should, on conviction, be found guilty of a misdemeanor, punishable by a fine not exceeding \$1,000, or by imprisonment in the county gaol not over one year, or both, at the discretion of the court.

Section 2. Wherever the woods or prairies in any township shall be on fire so as to endanger property, it shall be the duty of the justices of the peace, the supervisor and the commissioner of highways of such township, and each of them, to order such or so many of the inhabitants of such township, liable to work on the highways, and residing in the vicinity of the place where the fire shall be, as they shall severally deem necessary, to repair to the place where such fire shall prevail, and there to assist in extinguishing the same, or in stopping its progress.

Section 3. If any person shall refuse, or wilfully neglect to comply with such order, he shall forfeit a sum of not less than five nor more than fifty dollars.

The General Railroad Act of Michigan contains the following wise provisions. It was approved 1st May, 1873:

Article 4, section 16. Any railroad company building, owning, or operating any railroad in this State shall be liable for all loss or damage to property by fire originating from such railroad, either from engines passing over such road, fires set by the company's employes by orders of officers of said road, or otherwise originating in the construction or operating of such railroad: Provided, that such company shall not be held so liable if it prove to the satisfaction of the court or jury that such fire originated from fire by engines where machinery, smoke-stack, or fire-boxes, were in good order and properly managed, or fires originated in building, operating, or repairing such railroad, and that all reasonable precautions had been taken to prevent their origin, and that proper efforts had been made to extinguish the same, in case of their extending beyond the limits of such railroad, when the existence of such fire is communicated to any of the officers of such company.

Maine, like Michigan, has been a great sufferer from forest fires, and experience has taught her the necessity of careful and vigilant legislation.

An Act to protect forest and timber lands from fire, and to punish the careless and unlawful kindling of fires, was passed in 1855:—

Section 1. No person shall kindle a fire on land not his own, without the consent of the owner, under a penalty of ten dollars and costs, and to stand committed till the fine and costs are paid.

Section 2. If any person shall kindle a fire in any field, pasture, or enclosure, forest or timber land, not his own, without the consent of the owner, and the same shall spread and do damage to any buildings, fences, crops, cordwood, bark, or any other personal property, or to any wood or timber land, he shall, on conviction, be punished by a fine of not less than ten or more than five hundred dollars and costs, according to the aggravation of the offence, and shall stand committed till the fine and costs are paid.

Section 3. If any person shall maliciously, with intent to injure any other person, by himself or any other person, kindle a fire on his own land, or on the land of another person, and by means of such fire the buildings, fences, crops, or other personal property, or woods or timber lands, of any other person shall be destroyed or injured, he shall, on conviction, be punished by a fine of not less than twenty dollars nor more than one thousand, or by imprisonment in the common gaol or house of correction not less than three months nor more than twelve months, or in the State prison not less than one or more than three years, according to the aggravation of the offence.

Section 4. If any person shall, for any lawful purpose, kindle a fire on his own land, he shall do it at such time and in such manner, and shall take such care of it, to prevent it from spreading and doing damage to other persons' property, as a prudent and careful man would do, and if he fail so to do, he shall be liable in an action on the case to any person suffering damage thereby, to the full amount of such damage.

Section 5. Any person who shall enter upon the lands of another person, for the purpose of hunting or fishing, and shall, by use of fire arms or other means, kindle any fire thereon, shall be liable to the penalties of the first, second, or third sections of this Act, as the case may be.

Section 6. Persons engaged in driving lumber upon any waters or streams, may kindle fires when necessary for the purpose in which they are engaged, but shall be bound to use the utmost exertion to prevent the same from spreading and doing damage; and if they fail so to do, they shall be subject to all the liabilities and penalties of this Act, in the same manner as if the privileges granted by this section had not been allowed.

Section 7. The common right to an action for damages done by fire is not taken away or diminished by this Act, but it may be pursued, notwithstanding the fines and penalties set forth in the first, second and third sections of this Act; but any person availing himself of the provisions of the fourth section shall be barred in his action at common law for the damages so sued for. And no action shall be brought at common law for kindling fires in the manner prescribed in the same section, but if any such fire shall spread and do damage, the person who kindled the same, and any person present and concerned in driving such lumber, by whose act or neglect such fire is suffered to spread and do damage, shall be liable in an action on the case for the amount of damage thereby sustained.

Section 8. When a building or other property is injured by fire communicated by a locomotive engine, the corporation using it is responsible for such injury, and it has an insurable interest in all property along the route for which it is responsible, and may procure insurance thereon.

MINNESOTA STATUTES

1. That if any person or persons shall willingly and intentionally, or negligently and carelessly, set on fire, or cause to be set on fire, any wood, prairie, or other ground whatsoever, in any part of this State, every person so offending shall forfeit and pay not less than five dollars nor more than one hundred; and, in default of payment of said fine, shall be committed to the county gaol for a term of not less than thirty days nor more than three months: Provided, that this section shall not extend to any person who shall set on fire, or cause to be set on fire, any woods or prairie on his or her own farm or enclosure, for the necessary protection thereof from accident by fire, by giving to his own neighbors one day's notice of such intention: Provided further, that the neighbors come together and participate in the burning of any woods, prairies or grounds, the notice in this section shall not be necessary or given: Provided also, that this section shall not be construed to take away any civil remedy which any person may be entitled to for any injury that may be done or received in consequence of such firing.

2. The penalties provided in the foregoing section shall be recovered by action of debt before any justice of the peace in the county where such offence shall have been committed, upon the complaint of any legal voter residing within the county where such offence has been committed.

3. It shall be the duty of any person who shall have any knowledge of such offence, or of any legal voter of the county where such offence has been committed, to prosecute such offender in the name of the State of Minnesota, and all fines and penalties so received shall be applied to the rise and support of the public schools in the township in which such offence shall have been committed.

4. All Acts and parts of Acts inconsistent with the provisions of this Act are hereby repealed.

5. This Act shall take effect after its passage.

The statutes of Minnesota empower county commissioners to appoint persons to burn the grass (in every county invaded by grasshoppers) within their respective counties; but in no case before the fifteenth of May in each year.

In Missouri the penalty for wilfully setting on fire woods, prairies, or marshes, is from \$100 to \$500; half the fine goes to the person who gives the information.

In Nebraska the Revised Statutes contain the following provision in reference to fires:—

Section 160. If any person or persons shall hereafter, at any time, wilfully and intentionally, or negligently and carelessly, set on fire, or cause to be set on fire, any woods or other grounds whatsoever, in the inhabited parts of this territory, every

person so offending shall, on conviction, be liable to a penalty of not less than one nor more than one hundred dollars: Provided, that this section shall not extend to any person who shall set on fire any woods or prairies adjoining his or her farm, plantation or enclosure, for the necessary preservation thereof from accident by fire, between the first day of March and the last day of November, by giving to his or her neighbors two days' notice of such intention: Provided also, that this section shall not be construed to take away any civil remedy which any person may be entitled to for any injury which may have been done or received in consequence of such firing.

New Hampshire, by an Act passed in 1862, provides that any person kindling fire on land not his own shall be punished by a fine not exceeding ten dollars; and if such fire spreads and does damage to the property of others, he shall be punished by a fine of not less than ten dollars nor more than one thousand dollars, or by imprisonment for not less than one month nor more than three years, according to the aggravation of the circumstances.

The general laws of the State provide as follows in relation to damage done by railroads:—

Section 8. The proprietors of every railroad shall be liable for all damage which shall accrue to any person or property by fire or steam from any locomotive or other engine on such road.

Section 9. Such proprietors shall have an insurable interest on all property situate on the line of such road exposed to such damage, and may effect insurance thereon for their own benefit.

Section 10. Any insurance effected by the owners of such property thereon, so far insure to the benefit of the proprietors of such railroad that in case of loss such proprietors shall be entitled to a deduction from the damages of the amount received thereon, except the premium and expense of recovery of the same.

New Jersey's code resembles that of Michigan, in part, having reference to fires. The Act has some good measures for the government of railroad companies:—

Section 15. It shall be the duty of every railroad company in this State, and of every company or person operating or using any railroad in this State with a locomotive engine or engines, to provide such engine with a screen or screens, or cover or covers, on the smoke-stack or smoke-pipe of such engine, so as to prevent, as much as practicable, the escape of fire from the smoke-stacks of such engines.

Section 16. In any action brought for the recovery of damages for any injury done to the property of any person or corporation by fire communicated by a locomotive engine of any person or railroad corporation, in violation of the preceding section of this Act, proof that the injury was so done shall be *prima facie* evidence of such violation, subject, nevertheless, to be rebutted by evidence of the taking and using all practicable means to prevent such communication of fire as by said section required.

Section 17. If any company or person shall refuse or neglect to comply with either of the foregoing provisions of this Act for preventing the communication of fire from locomotives, they shall forfeit, for every such refusal or neglect, the sum of one hundred dollars, to any person who may sue for the same, to be recovered with costs in an action for debt in any court having cognizance thereof, one-half of the sum received to go to the person suing and one-half to the State, for the public school fund.

Pennsylvania has an efficient Act, passed in 1871, to protect timber lands from fire:—

Whereas it is important to the people of the State that timber lands should be protected from fire, which, owing to malicious conduct and carelessness of individuals, is causing great havoc in the young growing timber, especially upon our mountains; Therefore,—

Be it enacted, &c., that it shall be the duty of the commissioners of the several counties of this commonwealth to appoint persons under oath, whose duty it shall be to ferret out and bring to punishment all persons who, either wilfully or otherwise, cause the burning of timber lands, and to take measures to have such fires

extinguished, where it can be done, the expenses thereof to be paid out of the county treasury, the unexhausted land tax to be first applied for such expenses.

All the other States and Territories have laws for the prevention of fires, but much resembling those noticed.

PROVINCE OF QUEBEC.

An Act respecting Clearing Lands and the Protection of Forests against Fires.

[Assented to 24th December, 1870.]

Whereas it is expedient to determine the periods of the year during which fires may be lighted in forests, for the purpose of clearing lands; and whereas it is further necessary to protect forests against fires: Her Majesty, by and with the advice and consent of the Legislature of Quebec, enacts as follows:—

1. No person shall at any time set fire to, or cause to burn, any trees, shrubs or other plants growing or standing in any forest.

2. No person shall set fire to, or cause to burn, any pile of wood, branches or brushwood or any tree, shrub, or other plant, which shall be situate or felled in the forest, or at a distance of less than a mile, or any turf, peat, stumps, fallen trees or other timber, at any period of the year, for any cause or pretext whatsoever, except for the purpose of clearing lands, and in such latter case only between the first day of September and the first day of July.

3. Notwithstanding the preceding provisions, it shall be lawful to make a fire in or near the forests to obtain warmth, and for cooking or any other necessary objects, or for all industrial purposes, such as the manufacture of tar, turpentine, charcoal, or the making of ashes for the manufacture of pot or pearl ash, provided that the obligations and precautions imposed by the following sections are observed:

4. Every person who shall, between the fifteenth day of May and the fifteenth day of October, make a fire in the forest, or at a distance of less than half a mile therefrom, for the purposes mentioned in preceding sections, must—

1. Select the locality in the neighborhood in which there is the smallest quantity of vegetable matter, dead wood, branches, brushwood, dry leaves or resinous trees.

2. Clear the place in which he is about to light his fire, by removing all vegetable matter, dead trees, branches, brushwood and dry leaves from the soil, within a radius of twenty-five feet, as regards fires made for the necessities of any industry, as mentioned in section three, and a radius of four feet as regards fires made for other necessary objects mentioned in said section.

3. Totally extinguish the fire before quitting the place.

5. Any person who shall throw or drop on the ground, in any place whatsoever, whether in the forests, the open fields or other place, any burning match, ashes of a pipe, cigar or part of a cigar, or any other burning substance, or who shall discharge any fire-arm, shall be bound, under the pains and penalties of this Act, for his neglect to completely extinguish before leaving the spot, the fire of such match, the ashes of a pipe, cigar or part of a cigar, or wadding of such fire-arm.

6. Any person contravening any of the provisions of this Act shall be liable, upon conviction before any justice of the peace, to a penalty not exceeding fifty dollars, and in default of payment of said penalty and costs of suit, with or without delay, to be imprisoned in the common gaol of the district wherein he shall be convicted, for a period not exceeding three calendar months, unless the said penalty and costs of suit, together with the costs of apprehension and conveyance of the said offender to the said common gaol be sooner paid, or be imprisoned in the said common gaol not exceeding three calendar months; or to be condemned for each such offence to the said penalty, and further, to the imprisonment, herebefore mentioned, with costs of suit in all cases.

7. Any person of full age may prosecute for any contravention of this Act, and one-half of the penalty, in case of conviction, shall belong to the prosecutor, and the

other half to the Government of this Province, to form part of the consolidated revenue of the same.

8. Every suit for contravention of this Act shall be summoned within the three calendar months immediately following such contravention, and not afterwards.

9. Any justice of the peace who shall view any contravention of this Act, may impose the penalty thereof without other proof; and for the purpose of this Act, all agents for the sale of Crown lands, all sworn surveyors, all employés of the Department of Crown Lands, and all wood rangers employed by the Department of Crown Lands, shall be *ex officio* justices of the peace.

10. The Act thirty-three Victoria is hereby repealed.

PROVINCE OF ONTARIO.

An Act to preserve the Forests from destruction by Fire.

[Passed March, 1878.]

Whereas large quantities of valuable timber are annually destroyed by fires, which are, in many instances, the result of negligence and carelessness, it is therefore necessary to provide stringent regulations for the prevention of such fires:

Therefore Her Majesty, by and with the advice and consent of the Legislative Assembly of Ontario, enacts as follows:—

1. The Lieutenant-Governor may, by proclamation to be made by him, from time to time, issued by and with the advice of the Executive Council, declare any portion or part of the Province of Ontario to be a Fire District.

2. Every proclamation under this Act shall be published in the *Ontario Gazette*, and such portion or part of the Province as is mentioned and declared to be a Fire District, in and by the said proclamation, shall, from and after the said proclamation, become a Fire District within the meaning and for the purposes of this Act.

3. Every such portion or part of the Province mentioned in such proclamation shall cease to be a fire district upon the revocation by the Lieutenant-Governor in Council of the proclamation by which it was enacted.

4. It shall not be lawful for any person to set out, or cause to be set out, or started, any fire within or near the woods, within any Fire District, between the first day of April and the first day of November in any year, except for the purpose of clearing land, cooking, obtaining warmth, or for some industrial purpose; and in case of starting fires for any of the above purposes, the obligations and precautions imposed by the following sections shall be observed:

5. Every person who shall, between the first day of April and the first day of November, make or start a fire for the purpose of clearing land, shall exercise and observe every reasonable care and precaution in making and starting of such fire, and in the management and care of the same after it has been made and started, in order to prevent such fire from spreading and burning up the timber and forests surrounding the place where it has been so made and started.

6. Every person who shall, between the first day of May and the first day of November, make or start, within such Fire District, a fire in the forest, or at a distance of less than half a mile therefrom, or upon any island, for cooking, obtaining warmth, or any industrial purpose, shall:

(1.) Select a locality in the neighborhood in which there is the smallest quantity of vegetable matter, dead wood, branches, brushwood, dry leaves or resinous trees.

(2.) Clear the place in which he is about to light the fire, by removing all vegetable matter, dead wood, branches, brushwood and dry leaves from the soil, within a radius of ten feet from the fire.

(3.) Exercise and observe every reasonable precaution to prevent such fire from spreading, and extinguish the same before quitting the place.

7. Any person who shall throw or drop any burning match, ashes of a pipe, lighted cigar, or any other burning substance, or who shall discharge any fire arm within such Fire District, shall be subject to the pains and penalties imposed by this Act if he neglects completely to extinguish, before leaving the spot, the fire of such match, ashes of a pipe, cigar, wadding of the fire-arm, or other burning substance.

8. Every person in charge of any drive of timber, survey or exploring party, or of any other party requiring camp fires for cooking or other purposes, within such Fire District, shall provide himself with a copy of this Act, and shall call his men together and cause said Act to be read in their hearing and explained to them, at least once in each week during the continuance of such work or service.

9. All locomotive engines used on any railway which passes through such Fire District, or any part of it, shall, by the company using the same, be provided with and have in use all the most approved and efficient means used to prevent the escape of fire from the furnace or ash pan of such engine, and that the smoke-stack of such locomotive engine so used shall be provided with a bonnet or screen of iron or steel wire netting, the size of wire to be used in making the netting to be not less than number nineteen of the Birmingham wire gauge, or three sixty-fourth parts of an inch in diameter, and shall contain in each inch square at least eleven wires each way at right angles to each other, that is, in all twenty-two wires to the inch square.

10. It shall be the duty of an engine driver in charge of a locomotive engine passing over any such railway, within the limits of any such Fire District, to see that all such appliances as are above mentioned are properly used and applied, so as to prevent the unnecessary escape of fire from any such engine, as far as it is reasonably possible to do so.

11. Whosoever unlawfully neglects or refuses to comply with the requirements of this Act, in any manner whatsoever, shall be liable, upon conviction before any justice of the peace, to a penalty not exceeding fifty dollars, over and above the costs of prosecution, and in default of payment of such fine and costs, the offender shall be imprisoned in the common gaol for a period not exceeding three calendar months; and any railway company permitting any locomotive engine to be run in violation of the provisions of this Act shall be liable to a penalty of one hundred dollars for each offence, to be recovered, with costs, in any court of competent jurisdiction.

12. Every suit for any contravention of this Act shall be commenced within three calendar months immediately following such contravention.

13. All fines and penalties imposed and collected under this Act shall be paid, one-half to the complainant or prosecutor, and the other half to Her Majesty, for the public use of the Province.

14. It shall be the special duty of every Crown lands agent, woods and forests agent, and bushranger, to enforce the provisions and requirements of this Act, and in all cases coming within the knowledge of any such agent or bushranger, to prosecute every person guilty of a breach of any of the provisions or requirements of the same.

15. Nothing in this Act contained shall be held to limit or interfere with the right of any person to bring and maintain a civil action for damages occasioned by fire, and such right shall remain and exist as though this Act had not passed.

PROVINCE OF NEW BRUNSWICK.

(The Consolidated Statutes, Chapter 107.)

Section 16. Any person who shall kindle a fire in any woods or open place, and leave the same burning, without being properly secured, whereby damage may be caused to the property of any other person, shall forfeit a sum not exceeding eighty dollars, and be liable to an action for the damages sustained in addition thereto.

APPALLING CALAMITIES CAUSED BY FOREST FIRES.

GREAT FIRE OF MIRAMICHI.

McGregor's "British America" contains the following description of the great fire of Miramichi:—

In October, 1825, about 140 miles in extent and a vast breadth of the country on the north, and from 60 to 70 miles on the south side of the Miramichi River, became

a scene of perhaps the most dreadful conflagration that has occurred in the history of the world.

In Europe a conception can scarcely be formed of the fury and rapidity with which fires rage through the forests of America during a dry, hot season, at which period the broken underwood, decayed vegetable substances, fallen branches, bark and withered trees are as inflammable as the absence of moisture can make them. To such irresistible food for combustion we must add the auxiliary of the boundless fir forests, every tree of which, in its trunk, bark, branches and leaves, contains vast quantities of inflammable resin.

When one of these fires is once in motion, or at least when the flames extend over a few miles of the forest, the surrounding air becomes highly rarified, and the wind consequently increases until it blows a perfect hurricane. It appears that the woods had been, on both sides, partially on fire for some days, but not to an alarming extent until the 7th of October, when it came on to blow furiously from the westward, and the inhabitants along the river were suddenly surprised by an extraordinary roaring in the woods, resembling the crashing and detonation of loud and incessant thunder, while at the same time the atmosphere became thickly darkened with smoke.

They scarcely had time to ascertain the cause of this awful phenomena before all the surrounding woods appeared in one vast blaze, the flames ascending to from 100 to 200 feet above the tops of the trees, and the fire rolling forward with indescribable celerity, presented the terribly sublime appearance of an impetuous foaming ocean. In less than an hour Douglastown and Newcastle were in a blaze; many of the wretched inhabitants perished in the flames. More than 100 miles of the valley of the Miramichi were laid waste, independent of the north-west branch, the Battiboa and the Nappan settlements. From 100 to 200 persons perished within immediate observation, while thrice that number were miserably burned or wounded, and at least 2,000 were left destitute of the means of subsistence, and were thrown for a time on the humanity of the Province of New Brunswick. The number of lives that were lost in the woods could not be ascertained at the time, but it was thought that few were left to tell the tale.

Newcastle presented a painful scene of ruin and devastation; only 14 houses out of 250 remained standing. The court house, gaol, churches and barracks, with ships on the stocks, were all reduced to ashes.

The loss of property is incalculable, for the fire, borne upon the wings of a hurricane, rushed upon the wretched inhabitants with such inconceivable rapidity that the preservation of their lives could be their only care.

Several ships were burned in the harbor, while others were saved from the flames by the exertions of their owners, after having been actually on fire.

At Douglastown scarcely any kind of property escaped the ravages of the flames, which swept off the surface everything coming in contact with it, leaving but little time for the unfortunate inhabitants to fly to the shore; and there, by means of boats, canoes, rafts of timber, logs or any article, however ill-calculated for the purpose, they endeavored to escape from the scene, and reach the town of Chatham, numbers of men, women and children perishing in the attempt.

In some parts of the country all the cattle were either destroyed or suffered greatly, for the very soil was parched and burned up, while scarcely any article of provision was rescued from the flames.

The hurricane raged with such dreadful violence that large bodies of timber on fire as well as trees from the forest, and parts of the flaming houses and stores, were carried to the river with amazing velocity, to such an extent affecting the water in such a manner as to occasion large quantities of salmon and other fish to resort to land, hundreds of which were scattered on the shores of the south and west branches.

Chatham was filled with miserable sufferers; every hour brought to it the wounded and burned, in the most abject state of distress.

Great fires raged about the same time in the forests of the River St. John, which destroyed much property and timber, with the Governor's house and about eighty private houses in Fredericton. Fires raged at the same time in the northern parts of the Province, as far as the Bay de Chaleur.

It is impossible to tell how many lives were lost, as many of those lumbering in the woods had no friends or connections in the country to note their non-appearance. Five hundred has been computed as the least number that actually perished in the flames.

The destruction of bears, foxes, tiger-cats, martins, hares, squirrels, and other wild animals, was very great. These, when surprised by such fires, are said to lose their usual sense of preservation, and becoming, as it were, either giddy or fascinated, often rush into the face of inevitable destruction; even the birds, except those of very strong wing, seldom escape. Some, particularly the partridges, become stupefied; and the density of the smoke, the rapid velocity of the flames and the violence of the winds, effectually prevent the flight of others.

In Murray's "British North America," it is stated that the benevolent contributions received after this calamity were so ample that the surplus was employed in founding a school in the chief seat of the calamity.

GREAT FIRE IN WISCONSIN.

In 1871, a fire broke out in Wisconsin, which was very disastrous in its results. Like the Miramichi fire, it occurred after a season of protracted drought, and, like it, too, it took place in the early part of October. The scene was the northern part of the State, and the results in loss of life and property far exceeded anything hitherto known in the western States. The "Legislative Manual," of 1872, gives an account of it, written by C. D. Robinson.

The great fire of the summer and fall of 1871 will long be remembered by the people of Wisconsin. With the exception of a slight shower, of only an hour or two in duration, in the month of September, no rain had fallen between the 8th of July and the ninth of October—some three months. The streams, swamps and wells dried up, the fallen leaves and underbrush, which covered the ground in the forest, became so dry as to be as ignitable almost as powder, and the ground itself, especially in the cases of alluvial or the bottom lands, was so utterly parched as to permit of being burned to a depth of a foot or more. To use a poetical expression, which became almost a reality, "The sky was as brass, and the earth ashes."

For weeks preceding the culmination of this state of things in the terrible conflagration of the 8th and 9th of October, fires were sweeping through the timbered country, and in some instances the prairies and openings in all that part of Wisconsin lying north of Lake Horicon, or Winnebago Marsh, which was itself on fire. Farmers, saw-mill owners, railroad men, indeed all interested in exposed property, were called upon for constant and exhaustive labor, day and night, in contending against the advancing fire.

The saw mills in the pine region of Brown, Shawano, Oconto, Manitowee, Keewaunee and Door counties are, many of them, located in the very midst of the pine forests, surrounded with a *débris* of slabs, edgings, shingles, refuse, &c., forming a ready conductor for the undermining fires in the forests adjoining to the mills and houses around them. The work of protecting these mills was long, harrassing and exhausting, the ground being so dry that water could not be obtained from the wells, and the means of defence were mainly by circumvalating the property with ditches. These were, in main, effectual, so long as the fire presented the ordinary character of previous forest fires, not fanned by gales and supplemented by a long-heated and ignitable condition of the atmosphere, which, as we shall see, followed later on. In this labor of fighting fire the mill men, farmers and others were engaged throughout October, the exhausting work going with good cheer, in the constant hope that either the welcome rain would come or that finally the ground would be wholly burned over, and leave nothing further for the flames to feed upon. Still no rain came, and a gloom seemed to settle on the doomed region.

The long-continued labor of fighting the fire exhausted all energies, and an overhanging smoke permeated the atmosphere, sometimes so dense as to prevent seeing objects a few rods distant, seriously affecting the eyes and lungs. This was not alone the case in the forests, but also in towns and in largely cleared settlements. In Green Bay, Depore, Appleton, Oconto, Monomone, Keewaunee and other places,

the smoke was so dense that buildings at the distance of a square were invisible; and on the lake and bay the smoke assumed the dimensions of an immense fog, obscuring the shores and rendering navigation difficult. The fire also made travel on the roads difficult and often dangerous. Trees, fallen and burning, obstructed the highways, and bridges in every direction were burned. It was a compensation in these cases, however, if it could be called one, that where bridges were gone the streams were dried up, thus allowing them to be passed without much difficulty. The Chicago and North-Western Railway ran for fifty miles through this burning region, between Oshkosh and Green Bay, and it was only by the services of a large force of men stationed along that line that it was kept in passable condition.

The fires approached the track so closely in many places that trains had to run at increased speed to prevent their taking fire. As an illustration of the narrow escapes on that fatal Sunday of the 8th of October, we may mention that Older's Circus, a long and heavy caravan, composed of eighty horses and twenty waggons, passed safely along that day over the bridges between Green Bay and Manitowee, some of which were burning at the time, and nearly all of which were destroyed before night. If any one of the bridges which spanned the deep and impassable ravines on that road had been burned in advance of the progress of the caravan, it would have been hemmed in and destroyed. Many devices were resorted to for the protection of life, excavations were made in the earth, with earth-covered roofs, in which people sought refuge. Many resorted to wells, which, from the long drought, had become dry. And much property which had been taken from the houses and placed in the open fields for safety was destroyed. But time drew on, the ground was burned over, and the long-harrassed people began to take breath, believing that the worst was past.

This was the condition of things on Sunday, the 8th of October. The air was dense with smoke, and fitful blasts of hot air, so stifling that at times it was difficult to breathe. All these northern towns had kept ready, as well as they could, for the emergency. In Green Bay the fire-engines had been kept at work wetting the buildings, and an extra police force was detailed to keep watch. The buildings were so dry that a spark would set them on fire; flakes of ashes from the smouldering timbers fell in the streets like a snow storm; and the citizens were as anxious as if in the face of some impending calamity. A hot southerly gale was blowing, and in the midst of it a house took fire in the central part of the city. The interior was only slightly burned, however, and the fire was extinguished before it reached the outer air. Had it obtained headway imagination fails to comprehend the result.

The country on three sides of the town was on fire, and on the fourth, where lay the only apparent outlet, were the waters of the bay, into which must have swarmed the population to a death only preferable to that which followed at their backs. It was the same gale that swept over Chicago. That city was then burning, though we did not know it; and that day and night the deadly blast was sweeping through the country northward, filling the land with death and destruction, unknown, as well, to us.

A few miles, in a north-westerly direction from Green Bay, lay the village of Pishtigo, having a population of about 1,500. The place was a hive of industry, principally in the manufacture of wooden wares, lumbering, &c. There was a railroad (C. and N.W.) in course of construction, and it is believed that there was an additional transient population of 300 people on that terrible Sunday, 8th October. Of these people only 1,000 are accounted for since the fire, while all over the desolated plain and in the forests, and in the river bed, human bones attest the fearful loss of life.

The people all day seemed to have a dreadful premonition of some dreadful calamity impending. About eight o'clock in the evening an unusual and strange sound was heard—a gradual roaring and rumbling approached. It has been likened to the sound of an approaching railroad train—to the roar of a cataract—and men who had been through the war of the rebellion likened it to the roar of battle, with artillery booming in the distance.

The poor people, worn out with incessant watching for weeks, were panic-stricken at this new feature, the glare of which approached rapidly, but the fire came not in the usual way, along the ground, as they had been accustomed to see it, but consum-

ing the tree-tops, and filling the air with a whirlwind of flame—the stoutest heart quailed before it. There have been many theories in explanation of this phenomenon, but it is more reasonably attributed to the formation of gas in the long heated pine forests. Hundreds of people threw themselves into the rivers, others prostrated themselves on the ground, believing the last day had come, and that all the conditions of the prophecies had been fulfilled.

Of the village of Pishtigo there was not a vestige. The river was crowded with people, horses, cattle and swine; many were drowned at once; others sunk after exhaustion, while others survived the dreary long night's watch.

The subject is too painful to dwell upon. Next morning the remainder of the heart-stricken people made their way to the nearest villages; all doors were open with generous hospitality, and in the words of Mr. Robinson (from whose report I have condensed), "If there never was such a fire, there, also, never was before such a healing of its tears."

The fire extended over an area of 500 square miles.

The Abbé Pernon, a Catholic missionary, then in charge of a church at Pishtigo, has published a small book on the subject ("Le doigt de Dieu est là!"), in which he graphically describes the terrible scenes.

"Picture to yourself a country covered by a dense forest growth, in the midst of which, here and there, along the roads, a clearing of greater or less extent—sometimes half a league wide, to make room for a young city; and at other times, three or four acres, the beginning of a farm. Except in these little spots where the trees had been cut and burned, the whole country was a rude, vast, but majestic wilderness—woods, everywhere woods, and nothing else, as far as one might wish to go, from the bay towards the north and west. The surface was generally uneven; in valleys grew the cedar and the spruce; and on the sandy hills evergreens, and in the places where the land was dry and rich were all kinds of hardwood, oak, maple, beech, ash, elm and birch. The temperature of this region is generally quite regular, and propitious for all kinds of grain. The rains are frequent, and seldom fail in seasonable time. But the year 1871 had been exceptionally dry, and the farmers, availing themselves of this opportunity for enlarging their fields, had made larger cuttings for burning off. Some hundreds of workmen were also at that time employed in opening a railroad, and they used the axe and fire freely in advancing their work. The hunters and the Indians roam continually through these woods and forests, especially in autumn, at which season they follow up the streams to fish for trout, or scatter through the woods in hunting deer. When evening comes, they kindle a great fire, wherever they happen to be, cook their supper, spread down their blankets, and rolling themselves up, they sleep in peace, well knowing that the fire will keep off the wild animals that might be passing in the night. In the morning they depart, leaving behind the embers that have protected and warmed them, without a thought about extinguishing them. The farmers do the same thing themselves, so that in autumn these woods are everywhere filled with fires that have been kindled by the hand of man, and finding an abundance of dead leaves and dry branches, the flames spread to greater or less extent. When the wind rises, these fires sometimes take fearful proportions, and sweep everything furiously before them."

The fire around Pishtigo had been burning for weeks, and the town had more than one narrow escape. The Abbé says:—

"It was a grand spectacle to observe the fire in the night. It shot up to the summit of the largest trees, the flames coiling around them like immense serpents, and leaping from branch to branch, they illuminated the whole country, darting tongues of fire into the midst of the green foliage, they created a moaning through the forest, as in a fearful tempest.

"Every few moments some ancient firs along their enormous trunks suddenly became so many columns of flames, crackling for a time, and then falling with the noise of thunder, raising great clouds of sparks and dense volumes of resinous smoke. The sombre contrast of these volumes of black smoke above seemed to announce the speedy death and desolation of everything below.

"Thousands of birds, aroused from their perches, flew about, not knowing what direction to take, uttering cries that made the night still more hideous, as they called to their mates, turned a few times in the air, and then disappeared in the furnace of flame below them. Thus the night passed, all hearts praying for rain, but it came not.

"On Sunday morning the wind fell into a calm, the fires seemed to be dying out, and we began to hope that the danger was past. But about 11 o'clock, while many people were in church, a gust of wind made the edifice crack, and the whole congregation rushed out to see what was about to happen. The fire had a new start in a log cutting in the woods, and the wind was blowing strong from the north-west. The forest fires were raging worse than ever, and were approaching directly towards them. The air was literally filled with cinders and sparks of fire; the engine was brought out, and hundreds of buckets were got from the factory, and everything possible was done to prevent the fire from getting into the village. But suddenly there appeared a new danger, for the wind changed to the west, when the fires were rapidly advancing, and it seemed that nothing but a miracle could save the whole from destruction, and clouds of smoke filled the air so densely that no one could see what to do or where the danger was greatest. The most energetic measures were, however, adopted for arresting the progress of the fire, all hands being employed that could be brought to the work."

I have seen the prairie fires run with the speed of a locomotive. They are grand and terrible, but insignificant in comparison with a fire in the forest. In proportion as the woods are more dense and high and large than the prairie grass, by so much are the forest fires more intense and grand. The fires on the prairie, when driven by the winds, glide over the dry and dead herbage, but they soon leave no trace of fire behind, except the blackened surface; but in the woods fires travel quite as fast, but they hold out longer and produce a heat that is infinitely more intense. It is no easy matter to withstand a sweeping forest fire, for if you try to stay its progress you run an imminent risk of being surrounded by the flames.

The agony of suspense which these people endured during that dreadful afternoon was terrible. The wind from the west, accompanied by a black suffocating smoke, seemed to get red and redder, until suddenly there came an immense glowing red light, accompanied by a heavy roaring sound. The atmosphere became heavy and oppressive, and in a few minutes the unfortunate inhabitants became panic stricken. Amongst other remarkable features of the occasion he notes the electrical condition of the atmosphere. He says:—

"The phenomena that struck me as remarkable was a flashing light that shone suddenly, like grains of powder touched by fire, and that flew from room to room. It seemed as if the atmosphere were saturated with some gas."

The scene at the river, to which the people fled in their terror, he describes:—

"The vortices of wind, in their constant rise, had, so to speak, pumped up the smoke, the dust and the ashes, so that we could see clearly. The river bank, as far as the eye could reach, was crowded with people, upright and motionless, along the edge of the water. Some had their eyes open and raised to heaven, but most of them had no idea that they could do anything to save themselves, and some believed, as they afterwards said, that the end of the world was come. * * * Being out of breath I could not speak, but pushed into the river those that were nearest and plunged in myself. An instant later I heard a splashing all along in the water, and it was none too soon, for one could scarcely breathe; the intensity of the heat increased, and in a few moments nothing could withstand it. * * * Once in the water up to the ears, I thought myself safe from the fire, but it was not so. The flames ran upon the water as upon the ground; the air was filled with them, or rather the air was fire. It seized our heads, and we were obliged to throw water continually with our hands upon our hair and the parts necessarily exposed for breathing. Many persons had thrown clothing and bedding into the river to save it, and whenever any of this came within reach it was seized and used for covering, but it dried so quickly by the heat that though wet continuously it would take fire.

"The horrid whirlwind that had blown so fiercely when I left my place had, as I have remarked, clarified the atmosphere; the river was bright—brighter than

day—and looking up and down I saw everywhere heads just above the level of the water, some bare and others covered, but all continually throwing water upon their heads. Looking from the river, either to the right or to the left, the firmament showed nothing but fire—the houses, the trees, the atmosphere itself. Above my head, as far as my vision could penetrate space, alas! too clearly, I could see nothing but flames—immense billows of flame that covered the whole sky, and rolled one upon another, as if violently agitated, as we see clouds driven in a storm—a sea of waves and a horrible tempest of fire.

"After about an hour's stay in the water such as survived crawled out, chilled and scorched."

Further on, in his book, the author again refers to the condition of the air, just before the great outburst of fire. He says:—

"It is hard to doubt that the atmosphere was at that time saturated with inflammable gas, destructive to human life. I have mentioned the flashes of light leaping in my rooms just before I left my house. On going to the river I met, in some places, strata of air, in which I could hardly breathe, and where I had to stoop almost to the ground to catch breath, although the violence of the wind would almost throw me down in spite of my efforts to prevent it. While I was in the river, and on looking up, I could see, as it were, a sea of fire violently agitated by the wind, and immense waves of flame rolling one upon another, mounting to a prodigious height in the air, and, of course, far above the reach of all inflammable materials. How can this phenomena be explained without admitting that there were great bodies of some such gas collected in the air?

"It was passing strange, but some dead bodies showed no marks of burning, and although their pockets were untouched, their watches, copper coins, and other metallic objects were melted. How, again, did it happen that some human lives, here and there, on farms and in the woods, were saved? This is a difficult question to answer, except that the tempest did not rage everywhere alike."

In many places where valuable articles, such as books and other treasures, were buried one foot under the sand, they were entirely consumed.

GREAT FIRE IN MICHIGAN FORESTS.

The year 1881, like the years of the Miramichi and Wisconsin fires, was remarkable for a long summer drought. All through August and September fires had been burning in many places in the woods on the western shore of Lake Michigan, and in many places the settlers had fires going on to clear their lands; but no alarm or fear of disasters was entertained till about the end of August; the smoke caused the atmosphere on Lake Huron to become so thick as to make navigation dangerous. This state continued all through September, except slight variations caused by changes of wind.

The *Detroit Tribune*, of 11th October, 1881, says: "From every direction come tidings that the surrounding fires, for the past four weeks, have been lashed into fury by the recent prevailing high winds; the woods are blazing on every side, and the parched earth itself furnishing a free conductor for the harrowing and burning element that ran underneath, and thus, as well as on the surface, spreads far and wide. Farm buildings, fences, and stacks of hay and grain have fallen a prey; and the damage that has been inflicted on woodlands and farm fields is incalculable."

This great fire covered about 1,500 square miles of ground, and it is estimated that about 15,000 people lost their homes, crops and live stock. The number of human lives lost in these terrible fires will never be known, as in many places the heat was so intense that it consumed bones and all. Sailors on Lake Huron felt the heat 6 miles away. It withered the leaves on the trees 2 miles from its path. A lady, escaping with her little girl through the woods, met with some deer, which came up to her and walked close up to her, as if seeking her protection. Fields of corn and potatoes, not touched by the flames, were roasted by the heat.

A report, published under the direction of General Hazen, signal service office, says:—

"The speed with which the wind and flames travelled is almost incalculable. Large boulders were rolled along the ground as if they were pebbles. The conflagration is described as roaring like a tornado, and as giving fourth loud explosive sounds that were terrifying. As the storm advanced it uprooted great trees, blew down buildings, lifted people from their feet." An anonymous writer says: "Dark and gloomy swamps, filled with pools of stagnant water, the home of wild-cats, bears, and snakes, were struck and shrivelled and burned almost in a flash."

In the signal service report, already referred to, among other causes given are the protracted drought and strong winds (natural causes).

Acres of dead timber left standing from former forest fires, windfalls, "slashings," pine-tops, and other inflammable materials, distributed over hundreds of miles. Carelessness of settlers in the management of local fires.

The estimated value of buildings and live stock destroyed is about \$2,000,000, while the loss in fences and forest timber is variously estimated at from \$50,000,000 to \$100,000,000.